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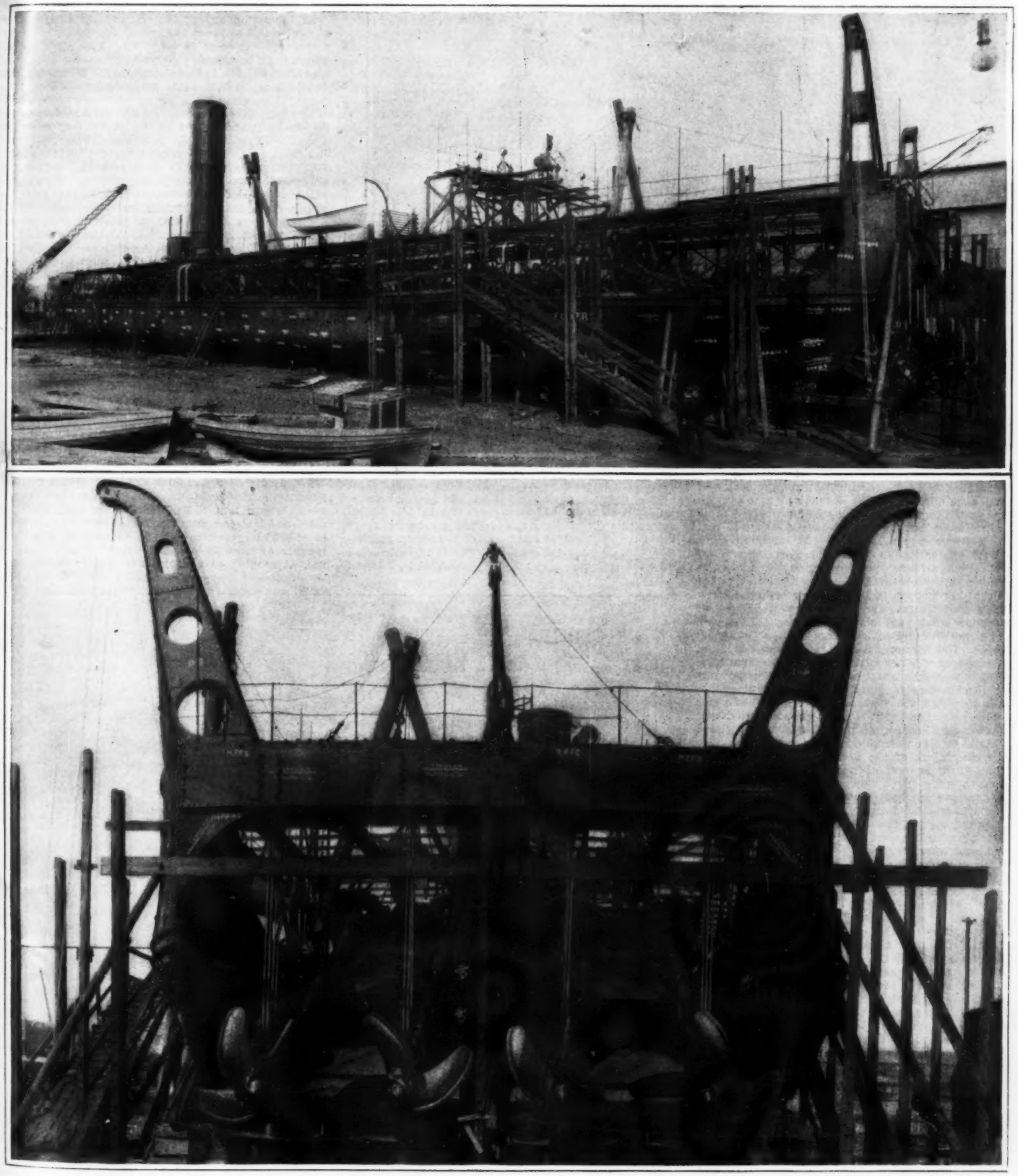


THE DREDGER "FOYERS." THE BOW IS OF TRIPLE FORM, CONSTITUTING TWO WELLS IN WHICH ROTARY CUTTERS ARE MOUNTED FOR EXCAVATING HARD MATERIAL. UNDERNEATH AND TO THE REAR ARE SUCTION PIPES.

A HUGE AND INTERESTING DREDGING PLANT FOR SERVICE IN INDIA.

A HUGE AND INTERESTING DREDGING PLANT FOR SERVICE IN INDIA.

By the English Correspondent of SCIENTIFIC AMERICAN.

ONE of the largest and most powerful dredging plants, the "Foyers," that has yet been designed, has recently been completed at the shipyards of Messrs. William Simons & Co., the eminent British engineers

MANEUVERING AND HOIST WINCHES.

in this class of plant, at Renfrew, Scotland, to the order of the Indian government. This installation, which possesses several interesting features, has been designed for a special class of work, mostly canal cutting, in the Bengal Presidency, where numerous irrigation and traffic intercommunication projects are to be undertaken. It is of the suction-pump, triple-screw canal embanking type, and is capable of cutting a canal or channel about 40 feet wide at the bottom in one cut, and depositing the excavated ballast either upon or beyond the banks of the waterway. The accompanying photographs of the plant show the installation at the shipyard of the builders, to whose courtesy we are indebted for permission to reproduce them in our pages, prior to dismantling and transport to India in sections, where the plant is to be reassembled.

As may be seen from the illustrations, the design of the vessel is upon somewhat novel lines, especially in regard to the forward part, there being provided three complete bows, forming for a length of about 35 feet of the hull two open wells. Each of these latter has a width of approximately 8 feet 6 inches. In each of these wells is a framework carrying suction piping, to which are attached two orifices or nozzles, together with shafting and gearing for a pair of rotary cutters, which are so disposed that they work in advance of the suction nozzles and serve to disintegrate the clay material, which could not be removed by suction pump dredging. Furthermore, each suction frame is fitted with a system of water jets delivered under high pressure for agitating compact sand, which might possibly prove insufficiently resistant to enable the rotary cutters to carry out the work of excavation. The water for these jets is delivered from two special centrifugal pumps arranged in series, and driven by an inclosed high-speed compound engine.

The cutters are of the Robinson patented type, of cast steel throughout, of massive construction, and special in form. Each pair of cutters is driven by bevel and spur gearing from an independent four-cylinder tandem compound engine, which is mounted on the deck at the edge of the wells. Each suction frame is controlled by independent hoisting gear driven by two-cylinder engines, and, when not at work or when the dredger is under propulsion, the frames, together with the piping and cutters which they carry, are hoisted clear above the water level. The vessel is provided with an arrangement of mooring horns at the bow end, for purposes of mooring while at work. These horns carry lengthy wire cable block and tackle, which connect with tube mooring piles sunk under pressure in the sandy bottom of the waterway, according to the precise exigencies or site of the operations in progress.

A little forward of the center of the vessel are placed two centrifugal sand suction pumps, which have a nominal dredging capacity of 4,000 tons of sand per hour from a depth of 20 feet. They are of special construction, with wide spaces to admit of the passage of large pieces of debris. Adjustable wearing pieces are provided to all surfaces liable to wear under the erosive action of the sand. Each suction pump is driven by an independent set of vertical triple-expansion engines developing 900 indicated horse-power. The pumps deliver the dredged material direct through a floating pipe line 600 feet in length and of 42 inches diameter, supported at its extremity by an offshore or terminal pontoon at a height of 20 feet above the water level, and the material is finally discharged over the bank of the waterway to a distance of 100 feet from the center of the supporting pontoon. This pipe line leaves the dredger itself at the stern, and a special swiveling coupling or connection is fitted, by means of which the pipe line can be connected directly astern or to a range of 90 degrees on either side of the center of the dredger.

The floating discharge pipe line comprises ten circular pontoons, each carrying a length of 60 feet of pipe of 42 inches diameter, and coupled together by special flexible connections. The terminal pontoon is fitted with a massive crane for supporting the embanking discharge pipe, and also two steam winches, each having three barrels, and arranged to work together or independently as required. There is furthermore a steam winch with powerful wire-rope tackle for controlling the embanking pipe, while steam for the winches and other plant is supplied from a vertical tubular boiler. One notable feature of this pontoon is an outboard balance weight carried on heavy davits at the side, and arranged so as to maintain the trim of the pontoon irrespective of whether the embanking pipe is full or empty.

The propelling machinery and gear of the "Foyers" is also an interesting feature of the plant. There are three sets of surface condensing engines, each driving a four-bladed propeller, the blades of which are of small diameter relatively to surface, and the engines and propellers are so designed as to be capable of developing sufficient power to maintain a speed of eight knots. Steam is raised in a battery of four Babcock & Wilcox water-tube boilers constructed to Lloyds' requirements for working at 200 pounds pressure, there being reducing valves fitted to suit the steam requirements of the various auxiliary engines. Distributed over the various sections of the plant, that is, between the dredger and pontoons, are no less than forty separate self-contained engines. There is one main condenser provided for taking the exhaust steam from the whole of the various engines, this section of the machinery having a complete outfit of steam-driven air and circulating pumps. The auxiliary engines include a vertical long-stroke feed pump for the boiler supply with automatic control gear; two vertical duplex general service and bilge pumps; two feed-water filters, each arranged so that the other can be overhauled when the dredger is at work; an evaporator for providing fresh water; also refrigerating plant and cooling chamber for preserving stores, etc. For night working, the vessel is provided with two powerful electric searchlights, one placed forward and the other aft, while the same illuminant is used throughout the plant, a complete generating installation being carried on board. There is also a complete workshop provided on the deck, equipped with forge and other machine tools, where general repairs can be easily and quickly effected on board while the dredger is at work, and irrespective of the position of the dredger during operations. One man has complete control of all the operations from the bridge, which is placed sufficiently high to give him a complete and uninterrupted command of the whole scene of operations, there being telegraphic communication from the bridge to the various working parts of the plant. For communication between the dredger and the terminal pontoon telephonic connection is provided.

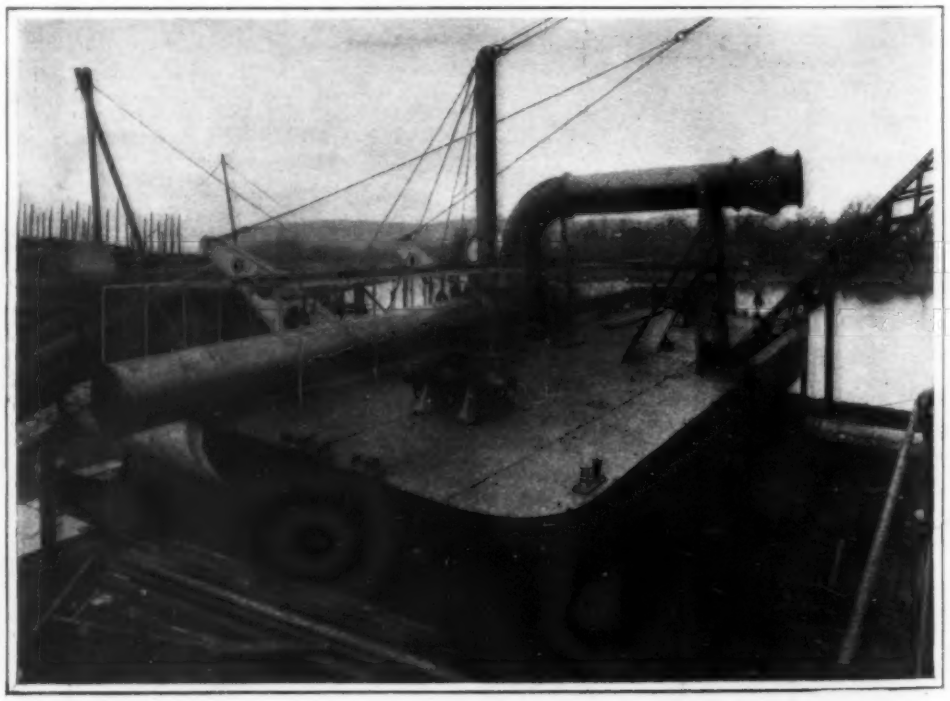
In the accompanying illustrations the "Foyers" is shown in the builders' yard ready for dismantling for transport to its destination. Owing to the facility with which teak and other timber suitable for the deck planking, outside belting, and general woodwork can be obtained in India, this part of the work will be prepared and fitted locally.

The hull of the dredger is 250 feet in length by 45 feet beam and 18 feet depth. It has been designed upon the initiative of Mr. O. C. Lees, the superintending engineeer, Southwestern Circle, Bengal Public Works Department, after a careful and exhaustive study of the dredging plants employed in America and Europe, and has been constructed under the direction of Sir. A. M. Rendel, K.C.I.E., the consulting engineer for the Indian government, under the direct superintendence of Mr. Seymour B. Tritton, M.Inst.C.E., M.I.N.A., of London. It has been more especially designed for opening new waterways, and improving the depths of existing shallow canals or rivers within the confines of the Bengal Presidency.

AN INTERESTING EXPERIMENT IN WOOD PAVING.

Wood has long been used for street pavements. Only within the past few years, however, has it been satisfactorily adopted in the cities of the United States. Previous failures can be traced almost entirely to improper construction or methods of preparation. In most cases round blocks of cedar or other woods were used, without precautions against decay and without adequate foundation for the pavement. The consequence was that, as a paving material, wood fell into disfavor.

Recent use of rectangular wooden blocks for street pavements has given excellent results. Many engineers believe that these blocks, when properly creosoted and laid on a concrete foundation, make a pavement which possesses high excellence in a greater number of essential qualities than any other now in use. Among these qualities are greater smoothness,



THE DISCHARGE EMBANKING PIPE.

A HUGE AND INTERESTING DREDGING PLANT FOR SERVICE IN INDIA.

low traction resistance, minimum noise, and, considering its smoothness, comparatively little slipperiness. Slipperiness has sometimes proved objectionable, but is not greater for wood than for sheet asphalt, all temperature conditions considered; and wood is much less variable in this particular than is the asphalt. It is probable that no other pavement with equally slight traction resistance will be found less slippery. Wood pavement is also easy to clean and to maintain, and

when well laid gives promise of proving more durable than any other except one constructed of the hardest granite.

The cost of creosoted wood pavement is at present comparatively high, averaging about $3 per square yard, including concrete foundation. In several cities, however, the cost of the pavement has been reduced materially below this figure, and good results have been secured. In Minneapolis, Minn., where the city itself lays the pavement, the total cost per yard is approximately $2.50. To attempt to cheapen the price, however, at the expense of thoroughness of treatment or careful construction is, with creosoted wood pavement, particularly dangerous economy. Even at the prevailing price, the excellence of this pavement causes many engineers to regard it as the best general purpose one now in use.

The five cities in which the largest amounts of wood pavement are found are, in order, Indianapolis, New York, Minneapolis, Toledo, and Boston. Together, these cities have more creosoted wood pavement than all other cities in the United States combined. The total amount of this pavement in use in this country at the end of the year 1905 was about 1,400,000 square yards, equivalent to nearly 80 miles of pavement on a street 30 feet wide.

Two main causes have militated against a wider adoption of the creosoted block pavement. One has been the prejudice which was engendered by the former experience with wood, the other is the rise in price of long leaf or Georgia pine, which is the wood now principally used. The Forest Service is making investigations to find out what woods are most suitable for use in paving, and whether less expensive woods could not be used to supplement the Georgia pine. The investigations have been upon three lines—to learn the present situation, to make tests of the suitability of various woods, and to lay experimental pavements and note their wear under actual traffic conditions.

An experimental pavement has now been laid in the city of Minneapolis, as a co-operative undertaking between the city government and the Forest Service. Different woods were donated, in lots of 15,000 board feet, by a number of lumber companies or lumber associations interested in extending the market for their respective woods. Creosote and treatment were contributed by two manufacturers of wood pavement.

The woods used were long leaf pine, Norway pine, tamarack, white birch, western larch, and Washington fir. All blocks were laid with the grain vertical, and were 4 inches in depth, 4 inches wide, and from 4 to 10 inches long. These blocks were impregnated with creosote and laid upon a foundation of Portland cement concrete. Successive sections of the pavement were laid in different woods. Also the angles of the courses were varied, one being at right angles to the traffic, another at 45 degrees, and a third between the two, or 67½ degrees.

This experimental pavement was laid on a street which carries the heaviest traffic of the city, so that comparative results can be obtained in as short a time as possible. Traffic records will be made twice a month, on different days of the week, and from these records an accurate knowledge of traffic conditions may be obtained.

This investigation should furnish definite information on the following points: The suitability of the various woods, the relative value of heartwood and sapwood, the best dimensions for the blocks, and the most serviceable angle for the courses.

COLLISION FORCES IN AUTOMOBILES.

By DR. WILLIAM F. DURAND, of Stanford University.

To those whom fortune or fate may have led into close contact with a railroad or automobile collision, perhaps the most impressive feature is the tremendous display of destructive energy, tearing a railroad car into kindling wood, reducing a locomotive to a tangled heap of iron and steel or smashing an automobile into an indiscriminate pile of match wood, twisted piping, distorted framing and crushed cast iron. Not every collision, of course, results in destruction so complete as indicated, but such possibilities are always present in connection with high speed practice, and some consideration of the more important conditions which determine the amount of destructive energy liberated in the event of collision and the character of its manifestation, should be of special interest to all who are concerned with the automobile, either as to its design or operation.

MACHINE COMPARABLE WITH PROJECTILE.

The situation may be realized most forcibly perhaps by recognizing frankly that an automobile or any other like body moving at a high rate of speed is simply a projectile and in every way comparable from the standpoint of mechanics, with the projectile from a modern high power field gun. When such a projectile is suddenly arrested in its flight, something must happen. The energy which the projectile has in virtue of its velocity must produce its equivalent in destructive work, and such destruction will be visited either on the projectile or the objects with which it comes into contact, or both, depending on the relative strength, hardness and resistant qualities of the two. Thus, if a projectile is fired from a field gun into a mass of timber the latter is much the less resistant of the two, and it is perforated, torn, and shattered with little or no damage to the projectile. The entire energy of the latter is expended on the timber with corresponding disastrous consequences. On the other hand, if the projectile is of cast iron and the opposing object a piece of hardened and resistant steel armor, the destructive energy is expended on the projectile and it becomes shattered into fragments. In the more common case when both are hardened and resistant to varying degrees, both are likely to suffer, each in proportion as it receives a greater or lesser share of the energy of the projectile at the instant of impact.

BRAKES APPLIED AT HIGH SPEED.

Now the conditions with an automobile, or in fact with any moving object, are exactly similar. In the case of the auto if the brakes are applied when going at high speed, the power being shut off, then the energy of the car is gradually and safely absorbed in overcoming the resistance of the brakes and in doing work which is thus transformed through friction into heat at the brake surfaces and gradually dissipated as such. In other words, the energy of the car is transformed into heat, the brake surfaces are gradually heated up, the heat is gradually conducted away, and no damage is done. Likewise in case the power is shut off on a smooth level road with clutch thrown out and brakes free, the car runs a long distance before it comes to rest; but in the end its energy is absorbed by the friction of the wheels and such attached mechanism as is kept in motion and in the friction and resistance of the tire on the road. Work is done at all these points, only a slight amount per foot of progress or per second of time, and so the car runs on for many feet or for many seconds before the initial energy is expended and the car comes to rest. If, however, the roads are sandy and heavy, the rate of doing work is much greater per foot or per second, the initial energy is much more quickly absorbed and the car comes to rest correspondingly. Again, if this should occur at the bottom of a hill the energy of the car is used up partly in friction and partly in lifting itself up the grade or slope.

EFFECT OF LIGHT OBSTRUCTIONS.

To draw nearer to the case of the projectile, if the automobile with power turned off should run into a series of light wooden lattices, the latter would be destroyed while the former would receive no serious structural damage and would experience but slight retardation. Still, with a sufficient number of such light obstacles and supposing friction and other resistances absent, the automobile would gradually and finally be brought to a standstill and the initial energy would have been expended almost wholly in smashing these lattices into kindling wood. Again, if the automobile at high speed runs into a board fence the latter will be smashed with comparatively small structural damage to the former, and with moderate retardation of its speed. A series of such fences would, of course, ultimately bring the machine to rest and more promptly than the lattices as the one is stronger than the other. Going up the scale to the extreme case we finally reach the point where the automobile at full speed runs direct into the face of a cliff of solid rock.* In such case the latter receives but slight punishment while the automobile is reduced to scrap. This is plainly on a parallel with the case of a cast-iron projectile which is fired at a plate of hardened steel armor.

QUESTIONS THAT OFFER A SOLUTION.

What is the *rationale* of these varying results, especially with the automobile? It is found in the answers to two questions:

(1) In the case of a collision between two objects, which of the two has the more strength or resistant capacity and which the lesser? The less the strength or resistance to the shock of impact or collision, the greater the share of destructive energy which will be absorbed and the greater the destructive effect, while conversely the greater the strength or resistance against such shock the less the share of energy expended on the body and the less the destructive effect.

(2) Through what distance does the moving body go between the first instant of impact and the time when it is brought to rest? Or, in other words, over what distance is the expenditure of the initial energy distributed? The less the distance over which the retardation acts the greater the average force manifested or required, so that if the body is gradually brought to rest over a long distance or run, the forces manifested or required are but slight and the destructive action will be small. On the other hand, if the body is brought to rest suddenly and within a short distance, as for example within its own length as when an automobile runs into a vertical stone cliff, then forces of the most terrific magnitude are manifested and the strongest material is bent, crushed, and broken beyond recognition.

Applying these principles, we readily see that in the case of an automobile running into a series of lattices, for example, the strength of the latter is much less than that of the former and hence the energy is expended on the lattices rather than on the automobile. Likewise, since the forces required are so small the rate of absorption of the energy is slow and a long distance is run by the machine before it comes to rest. The same is true in general and in varying degree if we substitute board fences for lattices. As we ascend the scale of resistance for the obstacle we soon reach a point where the resistance to rupture in the obstacle is perhaps as much as in the automobile, or at least, in some of its lighter parts. In such case the destructive energy will be divided between the two, both will suffer, and, the forces manifested being much greater, the distance run before coming to rest will be correspondingly less. Passing finally to the immovable obstacle, as the stone wall or cliff, the latter can receive only superficial damage and practically all the energy will be expended on the machine. Furthermore, as from the nature of the case the automobile must stop within less than its own length, the most tremendous forces will be brought into play and the machine will be smashed into unrecognizable scrap.

* One of the most notable accidents of this character occurred in April, 1903, at the La Turbie hill-climbing contest in France. Count Elliott Zborowski lost control of his 60-horse-power racing car at a turn, and, at full speed, collided with the side of a cliff. He was instantly killed, and his companion, Baron de Pallauge, was seriously injured. The machine was badly smashed up.

STRIKING ENERGY OF AUTOMOBILE.

As we show at a later point in the more mathematical treatment of the subject, the average value of the force manifested must be such that, multiplied by the distance through which it acts, the product will equal the initial or striking energy of the automobile. Or, inversely, we have at the moment of impact a certain amount of mechanical energy which will be transformed into destructive work measured by the product of the two factors, one the average force and the other the distance run. Hence, it follows that the less the one the greater the other and in particular the less the distance the greater the average force.

Now, measuring quantities in seconds, pounds, and feet, we may find the amount of initial or striking energy as follows:

Rule 1.—Multiply the weight of the moving object in pounds by the square of the velocity in feet per second and divide the product by 64.4. The quotient will be the striking energy or the work which must be absorbed somewhere in bringing the body to rest. This energy or work will be measured in foot pounds, the unit being the work required to overcome a resistance of one pound through a distance of one foot.

If, then, we wish to find the average force manifested, knowing the distance, we proceed as follows:

Rule 2.—Divide the striking energy by the distance run during the collision or while the body is being brought to rest, and the quotient will be the average force manifested over this distance.

It must not be forgotten that this is a distance average and that at local points and through short distances there will be manifested forces enormously greater than the average. This point will receive further consideration at a later point.

Again, knowing the average force or resistance which may be available for opposing the motion of the body, we may find the distance run as follows:

Rule 3.—Divide the striking energy by the average force and the quotient will be the distance run while being brought to rest.

EXAMPLE ILLUSTRATING RULES.

Thus, let us take for illustration a car in racing trim, with a weight of 2,200 pounds and traveling at a speed of 60 miles per hour. The latter speed figures out as 88 feet per second and we have:

Striking energy $= 2{,}200 \times 88 \times 88 \div 64.4 = 264{,}500$.

Now, if the car should have the power thrown off and expend an average brake resistance equivalent to 2,000 pounds at the tire surface, then the car would still travel about 88 feet before coming to rest. If the average total resistances reduced to the tire were as low as 1,000 pounds, then the car would run some 264.5 feet before stopping, while with 500 pounds similarly, the distance would be 529 feet. Going now to the extreme, suppose the car stopped within a forward travel of 10 feet for its center of gravity. Then the average force over this distance will be some 26,450 pounds.

If the speed should be 80 miles instead of 60, the higher value being often reached and even exceeded in road racing, then these values for the 2,200-pound car become respectively:

Striking energy, 470,000 foot pounds; for 3,000 pounds resistance, 157 feet run; for 1,000 pounds resistance, 470 feet run; for 500 pounds resistance, 940 feet run; for complete arrest within 10 feet, an average force of 47,000 pounds.

Again, take a large touring car filled with passengers and weighing 5,000 pounds. Then at the legal speed of 20 miles per hour we shall have as follows:

Striking energy, 66,800; for 500 pounds resistance, 134 feet run; for 1,000 pounds resistance, 67 feet run; for 3,000 pounds resistance, 22 feet run; for complete arrest within 10 feet, an average force of 6,680 pounds.

For a speed of 10 miles these various values would be only one-fourth as great, while for 30 miles they would be two and one-fourth times the above values, and for 40 miles four times the above values. These various illustrative figures will give an idea of the character of the *average* forces which acting continuously would serve to bring the car to rest within a 10-foot run, or assuming the action of continuous forces as specified, an idea of the various distances run before the car would be brought to complete rest.

MAXIMUM VALUES OF THE FORCES.

But this is by no means the worst and does not explain the character of the damage which is actually done. In the case of the 2,200-pound machine at 60 miles per hour, an average continuous force of 26,450 pounds over a distance of 10 feet would serve to absorb the energy and stop the car and would then represent the average display of destructive force. The actual destruction, however, implies forces far higher than 26,000 pounds or any force of this order. The existence of such greater forces is readily inferred from an inspection of the results and their existence is explained by the same principles which have been invoked to explain the character and the amount of the average force.

Suppose the framing of the chassis to come into sudden collision with a vertical stone cliff. The latter will suffer some superficial chipping, but in general it will not absorb any considerable share of the

energy, so that there will remain practically the entire amount of say 264,000 foot-pounds to be expended on the machine. Suppose now that the framing should undertake to hold its own or to yield only to the extent of say 1 inch. Then so far as the fastenings and connections hold, the entire 264,000 foot-pounds of energy would be available to create destructive force through that 1 inch, and the result would be the almost instantaneous liberation of a force of some 3,168,000 pounds—that is, supposing the framing to possess sufficient strength not to yield more than one inch and thus to bring about the development of such a force.

Actually when the force has run up to some figure far less than this, rupture or collapse occurs, something breaks or doubles up, the stress at that point is relieved and then as some further resistant item in the structure is reached the force begins to pile up again until the latter breaks or yields, and so on until the entire energy is absorbed and the whole mass comes to rest. The actual operation is therefore discontinuous and irregular to the last degree, one resistant member after another being overcome while the residual energy remains available to run the force up to breaking values, until finally such residual amount may be so small as to be taken up by the natural elasticity of the material. There is, therefore, not the slightest difficulty in accounting for forces of magnitude sufficient to bend, break, twist, or crush the structure of the machine in the manner which experience has demonstrated.

CONDITIONS AFTER IMPACT.

Now with these considerations in mind let us endeavor to picture the situation of affairs the instant after impact, remembering that the automobile is a highly complex structure with its various parts screwed, bolted, and fastened together in various ways. At the actual point of impact with a rock or cliff or other vehicle, for instance, there is opposed a resistance to the uniform velocity which all parts possess. The immediate effect is therefore a tendency to arrest the forward movement at this one spot on the machine. The instant this tendency is communicated by means of fastenings or by the action of connecting members to the other parts of the machine, corresponding forces will be set up throughout all parts of the structure and every part will be trying to break its fastenings or to tear itself apart at some point of weakness lying between itself and the arrested part.

Imagine, for example, fifty small balls of varying size and weight tied and interconnected together with string or wire and suppose such a system flying through the air at high velocity. Then imagine one of the balls to be caught and held fast. It is easily seen that the result will be a tendency for the remaining balls to fly onward, that forces will be developed tending to break all the individual fastenings and that so long as these fastenings hold, they will carry back to the point of arrest and put their whole combined effort on the connection between the point of arrest and the remainder of the system.

In the same manner with the automobile, so long as the fastenings hold and the various parts remain connected together, the entire system of forces developed throughout the various parts of the machine will all carry back and concentrate on the one point of attack until it yields under the enormous load thus thrown upon it, and similarly from one point to another until the entire initial energy is used up and all parts are brought to rest.

FAMILIAR COMPARISONS.

An interesting comparison may be made with the work required to pull apart longitudinally a bar of steel one inch square and one foot long. For impact forces we shall take this as about 9,000 foot-pounds. On this basis it follows that a 2,200-pound machine at a speed of 60 miles per hour would have energy sufficient for the rupture of some thirty such bars at once provided the arrest is sudden and the fastenings of the other parts hold in such manner as to develop the entire manifestation of force at one point.

From this standpoint an instructive view can be obtained by remembering that the energy which a given piece of metal can absorb before breaking is strictly limited by its mechanical properties, and that if a certain amount of energy is to be absorbed in destructive work, then the amount of destruction accomplished must be sufficient to represent the energy to be absorbed. Thus, as we have seen above, the energy of a 2,200-pound automobile at 60 miles per hour would serve to rupture some 30 bars of steel 1 inch square and 12 inches long. If the bars were only 6 inches long then it would require some 60 of them to absorb the energy and in any case they may be taken all at once or in any sequence or combination at will. Again, the same energy if expended in shearing 3-4-inch round steel bolts would cut through 500 bolts before exhausting the supply; or similarly through 260 1-inch steel rivets, or 2,500 1-inch square hard maple sticks or 25 10 by 10-inch square maple sticks.

Such like items might be combined in various ways and may be presented to the action of the destructive energy in any sequence and in any combination, and in all cases the result will be the continued destruction of one item after another until the energy is absorbed and the body brought to rest.

COMPARISON WITH FIELD GUN PROJECTILE.

Comparison may also be made with the energy of a projectile from a gun, and by the rules previously given it is readily seen that the 2,200-pound machine at 60 miles per hour would have about 25 per cent more striking energy than the 12-pound projectile from a 3-inch field piece with a striking velocity of 1,000 feet per second. While this comparison may be disappointing so far as the comparatively small size of the projectile is concerned, it must be remembered that in the latter case the energy is very much concentrated while in the automobile it is distributed through an enormously larger volume. Further, as we know from experience, if such a projectile is suddenly arrested by a piece of face-hardened armor sufficiently resistant to keep out the projectile entirely, then the latter, though of oil-tempered steel, will be crushed and broken into small fragments or in part fused into new forms. This same energy is present in the automobile and is available for manifestation at any one place, as at the point of impact, should it be needed in order to break or tear away such part. Actually no structural part of the automobile has the individual strength or resistant qualities of a 3-inch oil-tempered solid steel projectile, and thus long before any such concentration of energy can take place the point of first impact yields and another point is brought into play, and so the destruction proceeds from point to point as already explained.

In case two automobiles of about equal size and weight and with equal speed meet in head-on collision, we have double the total energy to be absorbed and double the material at hand for its absorption, so that the case is essentially the same as for collision with the stone cliff. If a large and heavy machine meets a small and light machine then the sum of the two energies will be quite unequally distributed, the smaller and weaker machine absorbing the greater share with correspondingly greater destructive effect on itself.

MATHEMATICAL TREATMENT OF THE SUBJECT.

For those who may be interested in the analytical development of these relations, we may state the equations as follows:

Let W = weight of moving object, measured in pounds.
F = average force over the distance required to bring the object to rest, measured in pounds.
L = distance over which force is exerted to bring body to rest, measured in feet.
V = velocity in feet per second.

Then energy $= \frac{W V^2}{64.4}$ in foot-pounds,

$F L$ = measure of destructive work done in stopping the body,

Then $F L = \frac{W V^2}{64.4}$

$$F = \frac{W V^2}{64.4 L}$$

$$L = \frac{W V^2}{64.4 F}$$

Or, otherwise and more generally, let E be any fraction or amount of energy which is lost in overcoming an average resistance F over a distance L.
Then:

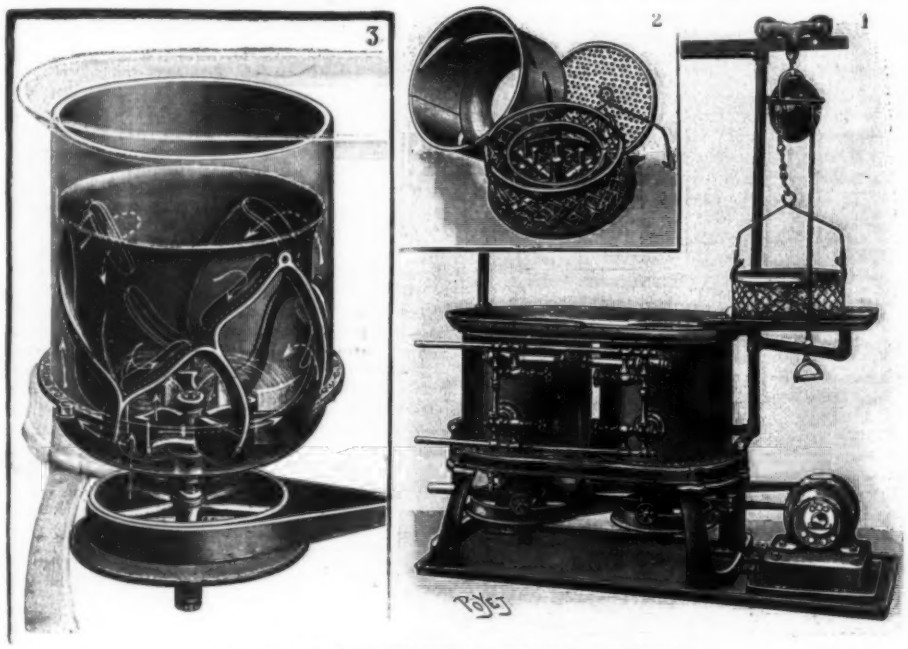
$E = F L$
$F = E \div L$
$L = E \div F$

In the actual case of automobile collision, F, as has been carefully noted, is merely a distance average of the force developed. It means simply that there will be as much destructive work done as would correspond to the exhibition of a force F over a distance L. Actually, the destructive work will be made up of parts each one of which may consist of a very much larger force acting through such smaller distance as may be needed for the rupture of the part in question.—The Automobile.

A MACHINE FOR WASHING TABLE UTENSILS.

THE accompanying figures illustrate a new machine designated for the thorough and cheap washing of three thousand pieces of table ware an hour without breaking or chipping. Fig. 1 gives a general view of the apparatus, which consists of two drums placed side by side and communicating with each other by pipes, water levels, and cocks. A carriage moving along a bar arranged for the purpose is placed above the drums and carries a pulley and chain for supporting the wire baskets in which the table utensils are placed. The baskets are shown in Fig. 2. In the drum to the left there is a double-walled receptacle to be filled with hot water to which washing soda and soft soap have been added. The inner wall is provided with six apertures placed diagonally at an equal distance from each other. At the bottom, beneath a grill designed to arrest solid matters, is placed a screw, as may be seen in Fig. 3. This screw is secured to an axis which is set in motion by a pulley which receives its impulsion from an electric motor through the intermedium of a belt. The screw in revolving sucks up the liquid and forces it violently between the walls of the receptable. The result is that the wash-liquor is continuously thrown against the utensils through the apertures in the internal wall. As a consequence of the chemical action of the hot liquid and the mechanical action of the continual displacement of said liquid, all the residua are carried along and the washing is perfect.

The operation of the apparatus, as may be seen, is extremely simple. The conditions of operation are also very economical. The power of the motor for revolving the screw requires about 370 watts. The output of water is extremely small. The manipulation of the basket is very easy and requires no effort.



MACHINE FOR WASHING TABLE UTENSILS.

1. General view. 2. Baskets for the reception of the utensils. 3. Receptacle for washing liquor actuated by an electric motor.

The method of using the apparatus is very simple and the operation is very rapid. The drum to the left is filled with hot water containing soda and soap in solution, and the rinsing one to the right with boiling water. The table utensils are placed in the basket, which is lowered into the washing drum, where it is allowed to remain about twenty seconds. The basket is then taken out and plunged twice into the rinsing drum, and afterward placed upon the platform which serves for drying, while another basket is being immersed in the washing drum, and so on.

Let us add that the operation of the apparatus is almost silent. The only movable piece subject to wear is the axis of the screw, which revolves at a great angular velocity; but this may be easily replaced at any time.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

Some engineers consider the back banks of tubes in their large boilers as feed-water heaters, but if they are to be utilized for this purpose, then the steam-temperature water from the furnace end of the boiler should not be allowed to circulate through them, as such steam-temperature water displaces the cooler water and drives it forward to the front end, thus reducing the temperature toward the front end and reducing the active steam-producing area within the boiler. To use the back end of any boiler for the purpose of heating feed-water is to be condemned, as the tubes are often bad conductors of heat, due to the dirt and soot upon them, and better efficiency would be obtained by cutting out the back part of the boiler, letting the gases away at a higher temperature and utilizing the waste heat in an economizer which has self-cleaning and efficient heating surfaces, and in which the range of temperature between the gases and the feed-water is greater than in the case of the back end of a water-tube boiler, where the feed-water is immediately raised in temperature by the hot water circulating from the active steaming end of the boiler.

MAKING FOUNDRY PATTERNS.

By WALTER J. MAY.

THE majority of persons who have not had work in connection with actual foundry work appear to think that each and everyone should get their single castings at the same rate as that charged for repetition work turned out in quantity, and that any manner or make of a pattern is good enough to secure both good and accurate castings. They generally get very much disappointed, however. It is no use to take a chunk of wood, rough it into the approximate form of the casting required, and daub it up with paint and putty if you want the best work at the lowest price, and this simply because your pattern is unworkable.

Even in some works running their own foundries, the greatest disregard is paid to the provision of first-class patterns, the result being that while the foundry costs are increased, the work turned out is not so good as it should be, nor is it so cheap; while the costs of machining are increased, and much metal wasted for no real economy. Very often the cry is "Anything is

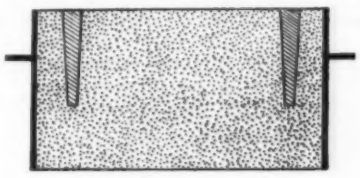


FIG. 1.

good enough for the foundry"; but this is a mistake, as while a good molder can usually turn out decent work quite irrespective of the quality of the patterns, yet the extra work he has to put in quite cuts out the question of cheapness. This applies to either hand or machine work quite indiscriminately, because the mending of molds takes as much time, or more, as making them, and at ninepence or more per hour a man's time is of more than passing interest in the making of castings or any other class of goods. You do not want to drive and harass a man to get your wages back anyway, but you do not want to employ men at a loss. This you will do in the foundry, however, if you do not provide proper patterns and materials, and the sooner this is generally understood the better for all who are concerned.

Now a pattern is a replica of the outside of a casting having additions in the way of prints where holes are to appear, and being as much larger than the finished article as the allowances for shrinkage and machinery necessitate. With the patterns the necessary core-boxes come in, and these provide the means for making the cores for the holes and internal hollows

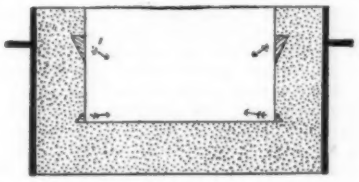


FIG. 2.

of the casting, the cores being of such a size where machining has to be done as to permit of a sufficiency of metal to be cut away. All metals and alloys have not the same rate of shrinkage or contraction, and all parts of a casting do not contract equally alike, and for this reason some little experience is necessary to enable one to produce patterns of the best design. Where an expert patternmaker is employed, all that is necessary is to give him scale drawings of the pieces for which patterns are required, and let him add the necessary allowances, but where the patterns are not made by an expert man, then the additions must be made to the drawings by the draughtsman, and usually he will make them on a regular scale, and probably will not use a contraction or "shrink" rule in making his measurements. In such a case, the contraction allowance should be ample without being excessive; but still a little more will be given than where an expert pattern-maker does the work, as probably the draughtsman will only be able to work from fixed formulæ. Really, he should have enough knowledge to allow of his being able to decide which will be the top and which will be the bottom of the casting when made in

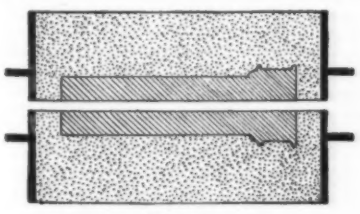


FIG. 3.

the foundry, or someone should be able to tell him this, otherwise some trouble may take place; but, in any case, foundry and drawing-office ideas are not always coincident. In all cases, where possible, the patterns should be made to the advantage of the molder, and where necessary, split patterns and loose parts should be arranged for when this conduces to ease in molding, and where it causes a reduction in the labor of mending molds. In every case where the castings are to be left unmachined, either wholly or in part, care must be taken to provide patterns most likely to leave a good surface to the mold, as generally speaking the less a mold is touched with tools, the better will be the result, while, as a matter of course,

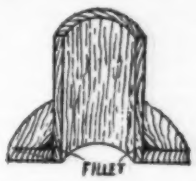


FIG. 4.

the less will be the cost of molding; and where the person using the castings is having them made to order, the cheaper he can get them done within certain limits.

Each metal generally in use in the ordinary run of work has its own shrinkage allowance given in most books; but from these the expert pattern-maker usually deviates somewhat, as very small castings do not need the shrinkage allowance, owing to their being rapped out more than enough, and up to, say, 2-inch cubes or spheres the shrink rule is rarely wanted. On the other hand, extra-large castings will often contract more than the standard allowance in some directions, and to provide against this only the experience of the molder and pattern-maker can be used, no fixed rules being strictly applicable to all cases alike. Nominally the shrinkage does not differ, but in practice it does, the matter not being wholly dependent on heat, or the mere process of solidification.

Theoretically, metals contract equally in all directions while cooling; but practically there is often considerable difference in the contraction of different

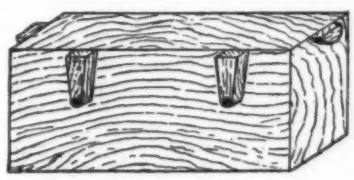


FIG. 5.

parts of large—or fairly large—castings, and this often causes trouble where the measurements are cut too fine. However, if the large patterns are made by a good pattern-maker, this need not trouble the person making the general run of small castings, which form the bulk of home-made patterns, and if he works with a shrink rule in making his patterns, and an ordinary steel rule in making his core-boxes, he will not be far out in his work; that is, assuming that he works exactly to measure, and does not use "near enough" calculations.

Patterns may be of wood, metal, plaster of Paris, or papier-maché; but usually they are of wood when only a small number of castings are required, metal being used where there is a long run of molds to be made from one pattern. Either mahogany or dry pine free from knots will be used for most things, and even when metal is used it is mostly the case that a wood pattern is made; but in such cases allowance for *double shrinkage* has to be made in accordance with the metals used.

After making the body of the pattern, core-prints have to be put on, and then the whole has to be varnished to prevent absorption of moisture, or "sucking"

FIG. 6.

as the molder calls it, and to provide a smooth, hard face against the sand. No paint may be used; but the varnish will be colored red or black, according as to whether brass or iron be used, the core-prints being colored the opposite color to the body of the pattern for the guidance of the molder. It is a good plan to finally coat with hard shellac varnish to give the smoothest face to the pattern, as this makes the molds turn out better and far cleaner as a rule.

In making patterns they must be so made that they will "lift" fairly, and where they are of any depth they must be slightly tapered, as shown in a greatly exaggerated form in Fig. 1, as if the pattern is exactly squared it will strain, even if it does not break, the mold. It does not matter as to the way the mold is placed for pouring; but for lifting or withdrawing the pattern it is essential that the smaller part of the pattern shall be at the bottom of the mold while the pattern is being withdrawn. If the sand overlaps the pattern when it is withdrawn the mold will be broken away, therefore it is necessary to have the patterns fairly made. Where beads or other projections are on the molds they should be loosely held by tacks or some other arrangement, and the molder will remove these loose parts after he has taken out the body of the pattern, this being shown in Fig. 2, beads at the bottom, and handles of a square box being taken out before inserting the center core. This saves time in molding and is a thing often done.

Splitting patterns conduces to very good and rapid work, one portion of the pattern being in the cope and the other in the drag part of the box when it is opened. This enables better lifts to be made, and also gives the chance of making better joints, while mending molds takes far less time. This method of making patterns is shown in Fig. 3, a pipe being taken as an example. Where split patterns are used they must be carefully doweled and the dowels should work easily while being a good fit. Rapping and lifting plates may also be used with advantage if they can be inserted in the right places; but otherwise they are rather a nuisance to the molder.

A good many things require a fillet run round the joints, even although such addition may have to be turned off the casting, and this fillet is for the sake of providing strength in other parts of the casting, particularly where cast iron is concerned. The metal does not like sharp corners and the crystals are badly arranged for strength where such occur, therefore a fair-sized fillet is cast on to assist the metal. Such an addition is shown in Fig. 4, a pipe flange being taken as an example; but a large number of other things may be found requiring this addition to insure the maximum strength in the castings; but this is a detail which must be decided on the requirements of each case. In some cases a fillet is not needed, while in others it is, and only when one knows for what purpose the casting is required can the point be definitely settled.

Core-prints are of different forms, according to their position, and when they occur at the top or bottom of a mold they are simply of the size and shape of the end of the core, this kind of print not affecting the lift greatly. At the same time, it is often advisable to have the print patterns on dowels, as this is an advantage to the molders. Where prints come on the side of the pattern in the mold, they should be put on as shown in Fig. 5, to permit the core to drop into its place readily, unless, indeed, they occur on the joint of the mold. The space left when the core is in position is filled with sand by the molder, and this part of the work does not affect the pattern-maker.

Where prints for the base of embedded cores, in which the point is to leave a space for the reception of the heads of holding-down bolts and the like, are dealt with, they have simply a plain strip the size of the base of the core as shown in Fig. 6, the molder arranging and fastening the core in position. The core-box determines the size and actual shape of the core; but only the portion embedded in the sand of the mold requires to be shown on the pattern.

The depth to which the core-print extends into the walls of the mold will vary from 1 inch to 3 inches, according to the shape and size of the core, the object being to hold the core firmly in position; but with very large suspended cores it may well happen that special arrangements for holding them firmly may have to be made. This will rarely affect the persons for whose benefit this paper is primarily written, however, and need not be further referred to, as usually patterns of this class must be made by professional pattern-makers, as there are other points than core supports to be considered.

Core-boxes are made usually of the size the cores are to be when finished, although in the large cores sometimes used some pattern-makers—not all—make an allowance for expansion of the core, although few can give any very clear explanation of the whys and wherefores of the allowances, nor can the writer find any general agreement on the subject. For all small cores it may be taken that measurements made with an ordinary rule will be accurate enough, however, and in regard to this, if we make the cores of the exact size of the aperture needed, things will come out all right so far as sand-cores are concerned, because even if the core does expand slightly, the contraction of the metal will counteract any slight expansion which may occur.

Core-boxes in a general way should therefore be made to produce a core of the actual size needed, plus the portions which enter the spaces left by the prints in the walls of the molds, and the boxes must be made in two or more parts, according to the shape of the cores. The pattern is practically a replica of the casting; but the core-box is a mold in which a replica of a cavity is to be made in sand, and this must be borne in mind all the time. Dowels are used to keep the parts of the boxes in position, and usually the core-maker uses clamps to hold the boxes in place while they are rammed up with sand; but these clamps do not affect the pattern-maker. The work should be very smoothly finished, and when done and the boxes very accurately fitted, a couple of coats of thin shellac varnish should be soaked into the wood and allowed to dry, after which they should be rubbed down with very fine sandpaper, and finally coated with a last coat of shellac varnish to give a polished surface from which the core will leave in a smooth state.

Of course, the amount of finish put on both patterns and core-boxes will largely depend on the amount of work to be done. Where single castings only are required, only one coat of varnish being given; but where a number of castings are required off a pattern it pays to finish well, as the time and cost involved are not great.

Wooden patterns should never be painted with oil paint, and putty should never be used, nor should glue. Stopping to take the place of putty should be made with finely-powdered dry whiting mixed with shellac varnish reduced with methylated spirit, and for this purpose ordinary shellac "knotting" thinned with methylated spirit is quite good enough for all or-

dinary purposes. When dry, this stopping can be worked down smooth, and will take the varnish well. Instead of glue, use fairly thick knotting, and use pins to hold the wood while the adhesive dries and hardens.

Plaster patterns are made on the same lines as wooden ones, and for some purposes, where only one or two castings are needed, are handier than wood, as when dry they can be scraped and worked up very easily, while additions can readily be made. When finished, plaster patterns should be thoroughly dried and then dipped in some cheap wax to destroy their porosity so far as the surface is concerned, or they can have a couple of coats of knotting applied for the same purpose. Thin patterns should be soaked in the wax, but large ones only require just sufficient penetration of the material to make them non-absorbent; otherwise they suck too much, and cannot be easily removed from the moist mold. Anyway, for temporary work where economy is the first consideration, plaster patterns have their use, and in making replicas of many things they are easier to work in than wood. It must be remembered that plaster contracts somewhat in drying, and this must be allowed for in making patterns with this substance.

Papier-maché patterns can be made with paper pulp, or with layers of well soaked paper glued together, and for thin work this material will answer very well. When mounted into shape and thoroughly dry, several coats of shellac varnish are necessary to prevent absorption of moisture, and then they keep their form in a satisfactory manner. In some places this material is used to a fairly large extent, more especially in preparing patterns for the production of metal patterns, and where a fairly powerful screw-press can be brought into work in their preparation, they can be made as hard as wood, and are less liable to warp than that material. Paper patterns, however, are scarcely subjects for amateur treatment.

Care must be taken that where narrow ridges are to be left in the molds, the patterns should have sufficient clearance for lifting: otherwise the molds cannot be made properly, and on this point particular care should be paid, for, although molders can do a lot in working up molds, a time limit has to be imposed on each job, and for this reason where patterns are badly made, they are often returned as unworkable—in fact, the writer, like a good many other men in charge of works, has very frequently refused work which, owing to the bad make of the patterns, would have taken too long a time to mold. The matter lies in a nutshell—a foundry, like any other industrial concern, is run with a view to making a profit on the capital employed, and where it is apparent that work cannot be done profitably it is simply avoided or refused: hence the necessity for good patterns.—English Mechanic and World of Science.

[Concluded from SUPPLEMENT No. 1608, page 25750.]

DIGEST OF THE REGULATIONS AND INSTRUCTIONS CONCERNING THE DENATURATION OF ALCOHOL.*

RESTORING AND REDENATURING PLANTS.

CENTRALLY located plants may be established for the purpose of restoring to a condition suitable for reuse and for redenaturing, if necessary, alcohol recovered by manufacturers; these plants to be located at such places as the Commissioner of Internal Revenue may deem necessary.

Warehouse: How Constructed.

A warehouse constructed in the manner in which distillery warehouses are constructed must be provided. This warehouse to be used for the purpose of storing recovered denatured alcohol received from manufacturing establishments. Either an apartment in this warehouse or a separate warehouse may be provided in which to redenature and store the restored alcohol. This apartment or separate warehouse, as the case may be, must be constructed in the same manner as denaturing bonded warehouses. It must be supplied with mixing tanks, and a room to be used as a denaturing material room must be provided. The apartment used as a denaturing bonded warehouse must be separated from the apartment used as a storage room for the recovered alcohol received from manufacturers, and there must be no openings or doors between the two apartments. The denaturing material room must be constructed in the same manner as similar rooms are constructed at denaturing bonded warehouses, and all of the appliances at denaturing bonded warehouses must be supplied. (Sec. 133.)

Cistern Room to be Provided.

A cistern room constructed in the same manner as are cistern rooms at registered distilleries must be provided. In the process of restoring the recovered alcohol by redistillation, it must be received into the cisterns direct from the worm or condenser in the same manner as distilled spirits are received into the cisterns at registered distilleries. The cisterns and cistern room must be supplied with the same kind of locks as are required for similar rooms at registered distilleries.

When the restoring and redenaturing plant is in operation it must be under the supervision and control of a storekeeper-gager or other officer designated by the collector of internal revenue.

This officer shall carry the key to the warehouse or warehouses used in connection with the plant and the cistern and cistern rooms. When operations at the plant are suspended for the day he is to lock the steam valves controlling the supply of steam to the several parts of the plant, and such other appliances as will prevent the plant from being operated during his absence. Under no circumstances is he to permit any work to go on during his absence, and he must exercise the same kind of surveillance over the plant as is exercised at registered distilleries. (Sec. 135.)

Application to be Made to Collector.

Any person desiring to establish a plant at which denatured alcohol recovered at a manufacturing establishment may be restored and redenatured may make application to the collector of internal revenue in the district in which such plant is to be located.

In this application he must state the exact location of said plant; describe all of the buildings located on the premises; give the size of each building, the materials of which it is constructed, and their location with reference to each other; and describe all apparatus intended to be used in the work of restoring alcohol. (Sec. 136.)

Upon receipt of the application the collector will, either himself, or by one of his deputies, visit and inspect the premises. He will determine whether or not the plant is constructed in accordance with the regulations, and whether or not the statements made in the application and the representations made on the diagram are true.

If he finds that the statements are correct and that the plant is constructed in accordance with the regulations, he will so indorse upon the application, and the collector will forward same to the Commissioner of Internal Revenue.

If the Commissioner is of the opinion that the establishment of the plant is necessary, and that it is constructed in accordance with the law and regulations, he will approve it and will so advise the collector. (Sec. 136.)

Bond for Restoring and Redenaturing Plant.

Upon receipt of notice from the Commissioner of Internal Revenue that the restoring and redenaturing plant has been approved, the collector must notify the proprietor of the plant of such approval, and thereafter he may receive upon his premises, restore, and redenature alcohol, provided he first makes a bond.

Penal Sum of Bond.

The bond required of the proprietor of a restoring and redenaturing plant must be in the penal sum of not less than the tax on the alcohol it is estimated will be restored and redenatured thereat in thirty days, and in no event shall it be less than five thousand dollars or more than one hundred thousand dollars. The sureties may be either personal sureties or a corporate surety duly authorized to make bonds under the existing laws. (Sec. 138.)

Quantity of Alcohol to be Returned to Manufacturer.

Alcohol restored and redenatured at a plant established for that purpose may be restored to a condition suitable for reuse in manufacturing processes only. Alcohol recovered by any manufacturer using either specially or completely denatured alcohol may be restored and redenatured in accordance with the regulations herein prescribed, but in each case the manufacturer sending alcohol to such plant to be restored and redenatured must receive back from such plant a quantity of alcohol equal to that sent to the plant to be restored and redenatured, less any reduction in quantity attending the necessary process of restoration. In no event may a manufacturer receive any greater quantity of alcohol from a restoring and redenaturing plant than is sent to such plant by him, allowance being made, of course, for the denaturants added; and in no event may alcohol redenatured at a restoring and redenaturing plant be delivered or disposed of for reuse to anyone except a manufacturer who has delivered recovered alcohol to such plant. (Sec. 139.)

No Other Business to be Carried On.

No business may be carried on on the premises of a restoring and redenaturing plant except such business as is incident to the work of receiving, depositing, restoring, and redenaturing alcohol received there, and no tax-paid alcohol may be received on these premises. The premises of all restoring and redenaturing plants must at all times be open to the inspection of duly authorized internal-revenue officers, and they have the right to observe the processes and methods employed, and take such samples of the product of the plant as in their judgment may be necessary. (Sec. 141.)

Plant to be Secured on Suspension.

When the plant is suspended the officer in charge must securely lock all valves and cocks controlling the supply of steam, and the furnace doors; likewise he must securely lock the cistern rooms and warehouses connected with the plant and deliver the keys to the collector of the district; and when the plant suspends operations it must be placed in such condition by the officer that it cannot be operated during his absence, or until notice has been given to the collector by the proprietor of his intention to resume work. When the proprietor of the restoring and redenaturing plant desires to suspend operations, he must give the collector of internal revenue notice of such intention; and when he desires to resume operations he must likewise give notice, and the collector will thereupon assign an officer to the establishment who has custody and control of it during the period of operations. (Sec. 142.)

Proprietor of Restoring Plant to Own Real Estate.

In his application for permit to operate a restoring and redenaturing plant the proprietor must state the name of the person or persons holding the fee-simple title to the real estate upon which the plant is located. If the title is not in the proprietor of the plant, he must secure the consent of the owners of such fee-simple title in the same manner as is required in the case of registered distilleries.

Manufacturer to Keep Record and Send Notice of Shipment.

A manufacturer using denatured alcohol and recovering it in process of manufacture, and desiring to have alcohol restored to a condition suitable for reuse in manufacture at a restoring and redenaturing plant, must deposit the alcohol as it is recovered in the designated storeroom on his manufacturing premises, in the same manner as required of manufacturers who restore alcohol on their own premises. He must keep a record, in which he enters the quantity of alcohol in wine and proof gallons recovered each day and stored in his storeroom. At such times as he may desire, he may ship such recovered alcohol to a restoring and redenaturing plant, but before it leaves his storeroom he must put it into suitable marked packages.

He must number these packages serially, beginning with No. 1.

Upon the credit side of his record he must enter the date upon which he sends any recovered alcohol to the restoring and redenaturing plant, the name of the proprietor of the plant to which it is sent, the number of packages, the serial numbers of the packages, and the wine and proof gallons.

Notice to be Sent to Collector.

Upon the date upon which he places in transit any recovered alcohol he must prepare a notice, in which he states the number of packages, the serial numbers of the packages, the wine and proof gallons, and the name of the restoring and redenaturing plant to which the recovered alcohol is sent. This notice must be in triplicate, provided the restoring and redenaturing plant is located in one district and the manufacturing establishment is located in another. If they are both in the same collection district, then it may be prepared in duplicate. One copy of the notice is to be sent to the collector of the district in which the manufacturing plant is located, another copy to the collector of the district in which the restoring and redenaturing plant is located (provided it is in another district), and the remaining copy to the officer in charge of the restoring and redenaturing plant. As soon as the recovered alcohol reaches the restoring and redenaturing plant the proprietor of the establishment must deposit it in the warehouse located on the premises, and it must remain in this warehouse until it is ready to be redistilled and restored. (Sec. 145.)

Record to be Kept by Proprietor of Restoring Plant.

The proprietor of the restoring and redenaturing plant must keep a record in which he enters the date upon which he receives any recovered alcohol. In this record he must give the name and address of the manufacturer from whom the alcohol was received, the number of packages, the serial numbers of the packages, the wine and proof gallons. Upon the credit side he enters the date upon which he sends any redenatured alcohol to the manufacturer, the name of the manufacturer, the number of packages, the serial numbers of the packages, the name of the officer inspecting the packages, the serial numbers of the stamps, and the wine and proof gallons. At the end of the month and before the 10th day of the ensuing month he must prepare and forward to the collector of internal revenue a transcript of this record. This transcript will constitute his return for the month and must be duly sworn to. (Sec. 146.)

Restored Alcohol to be Removed from Cistern Room to Denaturing Room.

As fast as the alcohol is restored it is drawn off into packages from the cisterns in the cistern room and gaged and transferred to the denaturing warehouse and at once redenatured. These packages are numbered serially, beginning with No. 1 for each restoring plant.

Alcohol Sent Out from Redenaturing Plants.

If the alcohol is redenatured by the use of special denaturants, then the same kind of notices as are given to the several collectors in the case of specially denatured alcohol sent out from denaturing bonded warehouses operated in connection with distilleries must be prepared and forwarded to the collector. Likewise, the manufacturer receiving the alcohol must give a notice to the collector of his district similar to that required in a case of specially denatured alcohol received direct from denaturing bonded warehouse. The manufacturer must charge himself on his record with the alcohol received in the same manner as is required in the case of alcohol received direct from denaturing bonded warehouse. (Sec. 151.)

Collectors to Keep Records.

Collectors in whose districts restoring and redenaturing plants are operated shall be provided with records in which shall be kept the account of each plant. In this record are entered the quantity in wine and proof gallons of recovered alcohol daily received and deposited in the warehouse at said plant, the number of packages, the serial numbers of the package, and the names of the manufacturers from whom received. The record must also show the quantity of alcohol in wine and proof gallons delivered to the proprietor of the plant each day to be restored, the names and addresses of the persons from whom received, the number of the packages, and the serial numbers of the

* In this digest only those portions of the regulations which are of interest to the distiller and the proprietors of restoring and redenaturing plants have been retained; the rules to be observed by government officers in keeping records, etc., have been omitted as well as the regulations controlling the use of denatured alcohol in manufacturing industries.

packages. Collectors must also keep records similar to those kept in case of denaturing bonded warehouses, showing the quantity of alcohol deposited in said redenaturing warehouse, the quantity of denaturants deposited in the material room, the quantity of alcohol and denaturants dumped each day, and the quantity of redenatured alcohol withdrawn from dump, gaged, and delivered to the denaturer. (Sec. 152.)

THE MODERN MANUFACTURE OF ILLUMINATING GAS.

By Dr. OTTO ROEHM.

IN recent years many changes, largely of chemical character, have been made in the manufacture of illuminating gas. The manufacture falls naturally into two parts—the production of the crude gas from coal and the removal of the impurities—tar, water vapor, naphthalin, ammonia, hydrocyanic acid, sulphureted hydrogen, etc.—with which it is contaminated.

Coal gas is still produced by the dry distillation of coal in clay retorts, of which several are built into each furnace. For a long time these retorts were horizontal. Afterward they were inclined at an angle of 32 degrees, with the door at the lower end so that the coke was discharged automatically when the retort was opened. Quite recently a further improvement has been made by the employment of vertical retorts, which can be opened at the top for the introduction of the coal and at the bottom for the discharge of the coke. The first furnace of this kind, containing ten retorts, each 13 feet high, was set up in Dessau a few months ago, according to the designs of Dr. J. Bueb, who has studied the subject for many years and claims for the new system many advantages, including an increased yield of gas almost free from naphthalin, a thin tar, a hard coke, saving of labor, and an increase of 50 per cent in the yield of ammonia. Although it is too early to pronounce a positive opinion on the merits of the vertical oven, the results just quoted seem very promising.

From the retort the crude gas goes to the cooling apparatus, which receives it at a temperature of about 212 deg. F., and gradually cools it to from 22 to 27 deg. F. In the process of cooling, the greater part of the water and tar are condensed. The tar carries with it much of the naphthalin, especially if the gas has remained long in contact with the cloud of tar drops, that is to say, if the cooling has taken place very slowly. Rapid or incomplete refrigeration, on the other hand, increases the quantity of naphthalin that remains in the gas. This naphthalin is deposited in solid form in the cold underground gas pipes, where it causes trouble with which gas-house managers are only too familiar. It is advisable to determine the quantity of naphthalin in the gas at frequent intervals in order that precautions may be taken against clogging of the pipes. For the removal of the naphthalin, in addition to slow and thorough refrigeration, washing the gas with anthracene oil is very effective. Dr. Bueb has introduced this method into many gas works with excellent results. The anthracene oil, before being used, should be as free from naphthalin as possible and should be mixed with about 5 per cent of benzol, as the pure oil absorbs from the gas benzol and other useful hydrocarbons as well as naphthalin. From 1 to 10 ounces of anthracene oil are required for 1,000 cubic feet of gas, according to the quantity of naphthalin in the gas and the temperature at which it is washed.

The degree of saturation of the oil with naphthalin is determined by fractional distillation, the portion which comes over between 360 deg. F. and 486 deg. F. being regarded as naphthalin. My experiments have proved the advantage of testing the gas as well as the oil for naphthalin, before and after washing. In this way the thoroughness of the washing can be ascertained and excess or deficiency in the quantity of oil used can be corrected. The quantity of naphthalin in the gas can be measured very simply by washing the gas with a solution of picric acid of known strength, removing by filtration the precipitate of naphthalin picrate thus formed and determining by titration the quantity of picric acid which is left uncombined in the filtrate. The quantity of acid consumed and the quantity of naphthalin combined with it can thus be computed. Erdmann has endeavored to utilize the formation of naphthalin picrate for the removal of naphthalin from gas, in commercial practice, but the process has not yet been adopted. It has also been proposed to remove the naphthalin by means of caoutchouc, which has the property of precipitating or absorbing it.

Attempts have recently been made to remove the naphthalin by protracted cooling instead of by washing. The gas flows upward through "volume coolers," or very wide pipes, which greatly reduce the velocity of the current and thus give the tar time to precipitate slowly and carry the naphthalin with it.

For the removal of the finest cloud of tar particles, which has hitherto been satisfactorily accomplished by separators of various forms, but all acting by impact, centrifugal separators have lately been proposed, but experiments with them have not yet led to any practical result.

The removal of ammonia, which follows the removal of tar, is one of the most important operations of the gas works because of the high price which ammonia still commands. This operation should receive special attention from the chemist of the works because even slight variations in the temperatures of the gas and the wash water may occasion serious losses of ammonia. The more thoroughly the gas has been cooled and the colder the water the smaller is the quantity of water required for the extraction of all the ammonia and the greater is the strength of the ammoniacal liquor produced, which is to be the source of concentrated ammonia solution, ammonium sulphate and other products. In addition to stationary washers, filled with coarse material for the purpose of distributing the wash water through the gas, rotary washers are much employed. The latter are horizontal cylinders divided into six or eight compartments and containing revolving brushes or bundles of splints. These machines, through which gas and water flow in opposite directions, are very practical and efficient.

In regard to the removal of cyanogen, an important improvement must be mentioned. This is the substitution in a number of establishments in recent years of wet processes for the formerly universal dry process in which the cyanogen and the sulphureted hydrogen were extracted together, the cyanogen in the form of Prussian blue. In this change also Dr. Bueb has been instrumental and his method appears to be the one most commonly employed. In this process the crude gas not yet freed from ammonia is conducted to a rotary washer where it comes into contact with a solution of ferrous sulphate (green vitriol). A sulphide of iron is first formed and then, gradually, an insoluble ammonium ferrocyanide, of which the formula, according to Hand, is $(NH_4)_2 Fe_2 Cy_6$.

In many works the cyanogen is removed by washing the gas, after it has been freed from ammonia, with mixed solutions of ferrous sulphate and lime or soda, thus producing calcium or sodium ferrocyanide. The employment of the wet method, however, is not extending rapidly, probably because its advantages do not outweigh the complication which it necessarily introduces into the manufacture of gas.

The methods used for the removal of sulphureted hydrogen have undergone little change, and attempts to introduce wet processes have not yet met with practical success.

In describing the manufacture of illuminating gas it must not be forgotten that many, especially of the larger works, produce a mixture of coal gas and water gas. This mixed method is adopted particularly by establishments which have reached the limit of their capacity for producing coal gas and seek to supply the increasing demand, without erecting new and costly coal gas works, by means of water gas, the manufacture of which is comparatively simple. Independently of this consideration, however, several large gas works have quite lately taken up the manufacture of water gas. As the heating power of water gas is only about half as great as that of coal gas, it follows that a simple mixture of the two must be inferior to pure coal gas. The lacking heat units of the water gas must first be supplied by carbureting it with benzol, heavy petroleum oils or oils derived from lignite or carbonaceous shale. I cannot here go into the question of the stage of the manufacture of water gas at which the carbureting can be effected most advantageously—a question of considerable importance, as it affects the quantity of naphthalin in the gas. I will, however, suggest the advisability of exercising great care in adding the carbureting liquid to the water gas in order that the final product, the mixed coal and water gas, shall be of uniform composition. It is especially important to know the exact constitution of the coal gas produced in a factory if it is desired to replace this coal gas by mixed gas of equal value.

Although the introduction of water gas involves a complication of the manufacture, this disadvantage is compensated by many advantages, among which is the possibility of producing gas quickly, which is an important consideration in gas works which have to supply a very variable demand. A water-gas generator delivers gas in half an hour after it is set into operation while a coal retort requires two days to effect the same result.

After mentioning these special points I will make a few general remarks.

To a person ignorant of the subject it might appear that modern gas works run themselves so long as the machinery is kept in order. This is true, to a certain extent, but the expert knows that the furnaces, the washers for ammonia, cyanogen, and naphthalin, the ammonia manufacture, and all the operations require the constant attention of a chemist if the maximum output and the greatest profit are to be obtained. That this recognition of the necessity of the work of the chemist is steadily becoming more evident, in this as in other industries, is shown by the increasing number of gas works which employ chemists regularly. The task of a gas works chemist, however, should not be restricted to seeing that the manufacture is carried on properly, but should include the application of his scientific knowledge to the solution of the many practical problems which are sure to present themselves. The fact that much chemical research is still needed has been recognized by the Society of German Gas and Water Analysts, which has founded in Karlsruhe a laboratory for research in the chemistry of gas and placed it under the direction of Prof. Bunte, of the Karlsruhe Technical School. But this laboratory cannot supersede the factory chemist and, besides, the more numerous the observers are the sooner can defects in manufacture be detected and remedied.

Every industry endeavors to gain its ends in the simplest way. It cannot be said that gasmaking is yet very simple, and when we consider that only about 75 per cent of the coal is converted into gas it may be asserted with confidence that the methods now in use are still far removed from the ideal process, by which all the coal would be converted into gas in a single operation.

When we also take into consideration the cost of transportation of the coal and coke, the continual improvement in the application of electricity to the production of light, heat, and power, and, on the other hand, the fact that the gas engine is twice as efficient and economical as even the largest steam engine, we are compelled to ask if the gas industry must not, sooner or later, abandon direct competition with electricity and enter its service by furnishing cheap gas which, burned in gas engines at once at the place of production, shall generate current flowing from a central station to scattered consumers of light, heat, and power. The advantages of such an alliance of gas with electricity are obvious. I need mention only the abolition of gas pipes, the cost of maintenance of which amounted in 1903, for the Mariendorf gas works of Berlin, to one-quarter of the entire operating expenses—not to speak of the loss due to leakage.

But whether gas is to be furnished for the generation of electricity or for other purposes, the demand for cheaper gas remains the same.

According to the Mariendorf report just quoted 27 per cent of the total operating expenses were consumed in the furnace room—a showing which, as the compiler says, calls loudly for a new method of making gas.

From all this it is evident that in the manufacture of gas a wide field of activity remains open to the chemist. The development of the application of electricity will make new demands upon the gas maker that chemical science must meet.

The art of gas making, like all other arts, has not reached, and never will reach, perfection.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from an address to the Society of German Chemists.

CAISSON DISEASE.

THE work of constructing several tunnels under rivers, requiring the use of caissons, or "air locks," has caused a relatively rare disease to become common in New York and the subject of some general interest. The "bends," as this malady is called by workmen, was first observed among pearl divers, but it was a considerable time before medical men understood the cause of the peculiar condition, and then it was by an accident that the discovery was made. A French investigator in physiology, M. Bert, while studying the effects of increases in air pressure on animals, had the good fortune to have his apparatus explode. The dog in the glass bell of the compression pump died immediately. The idea occurred to Bert that perhaps he had simulated in this accident the conditions which cause caisson disease, and he set to work to find out of what his dog had so suddenly died. The only abnormal condition Bert could find was the presence of bubbles of air in the heart, and that this was an adequate cause for death had been known since the time of Galen. A careful repetition of Bert's experiment has shown that the conditions he found are almost always present when death results from sudden decompression.

Studies made by medical men have confirmed Bert's theory in its application to man. Under ordinary conditions a certain amount of air is dissolved in the blood. If the external air pressure be increased, as it is in a compression lock, to two or three times atmospheric pressure, the result is that a much larger quantity of air goes into solution with the blood. Then if decompression (the return to normal atmospheric pressure) is quick, the dissolved air escapes as bubbles into the circulation and much harm results to the individual, in that these air bubbles act as foreign bodies in the blood vessels and obstruct the flow of the blood. At times the escape of the dissolved air from its state of solution in the blood is so violent that it ruptures a blood vessel.

Since Bert's notable experiments many other studies have been made with a view of finding means to prevent this malady. Until recently the most notable data were those collected by a French engineer, M. Hersent, who conducted his experiments in the presence of members of the Bordeaux faculty of medicine. But more important in practical value are the experiments of two London physiologists, Hill and Macleod, who found that monkeys could endure with ease a pressure of eight atmospheres and suffer no apparent injury to their health, provided the decompression were made slowly. Hill then had constructed a steel cylinder of 42 cubic feet capacity, with a motor-driven pump for effecting air compression. In this cylinder Hill and his coworker Greenwood subjected themselves to varying degrees of pressure up to 90 pounds, which is equivalent to a water depth of more than 200 feet. Both of these investigators recorded their sensations while under pressure in the cylinder. One curious fact often noted by those who work in caissons is explained. In a caisson where the pressure is above three atmospheres it is quite impossible to whistle. Hill finds this is due to an interference with the vibration of the lips; at higher degrees of pressure speech becomes difficult also. After numerous experiments on themselves these authors conclude that there is no danger to healthy men in barometric pressures of at least seven atmospheres, provided there is rigidly observed a gradual decompression period. It is most emphatically affirmed by Hill that "every death or case of paralysis from air embolism must be set down to negligence of the contractor."

It has been repeatedly noted by pathologists in New York that persons dead of caisson disease frequently

show evidences of pulmonary tuberculosis. This is a reason for most careful physical examination of tunnel workers in order that only sound, healthy men may be employed. The evidence all goes to prove that if proper precautions were always exercised to compel employees to undergo decompression slowly the "bends" would be an almost unheard-of disease.—N. Y. Tribune.

PRODUCTION OF PETROLEUM IN 1905.

DURING the year 1905, the oil fields of the United States produced 134,717,580 barrels of petroleum, as against 117,080,960 barrels in 1904. This production was greater by 17,636,620 barrels than that of any previous year. It is an increase over the production of the year 1900 of 71,097,051 barrels, or considerably more than any total yearly production up to 1902. The production of petroleum in the United States has more than doubled within the last six years. The increase is in the heavier grades of the fuel class, the production of lighter or illuminating oils having remained constant

It is significant, however, that the value of the oil production for the year 1905 was $17,018,056 less than for the year 1904. The 117,080,960 barrels of oil produced in 1904 were valued at $101,175,455 whereas the 134,717,580 barrels of 1905 are rated at only $84,157,399.

A simple statement of the number of barrels of petroleum taken from the earth each year no longer shows the condition of the business. The kind and quality of the oil produced must now be taken into consideration in order to understand the relation of production to demand and consumption.

Of the production of the year 1905, 70,474,078 barrels are from the Gulf and California fields. This is almost exactly the quantity by which the production of the year 1905 exceeds that of the year 1900. The petroleum of the Gulf and California fields is of the heavier variety and has a residue of asphaltum. Oil of this quality, although capable of producing a small percentage of illuminating oil, is principally valuable as a fuel. The consumption of heavy oils must therefore depend on the demand for this kind of fuel. The growth of this demand is bound to take time.

The present price of petroleum of the Gulf and California type is no determination of its value. For a period of five years the production in this quarter has been faster than the rate at which the commercial world could adjust itself to the use of the new fuel. It is improbable that this great increase in production can go on indefinitely and as the steady increase in the consumption of oil for heat-making purposes is an assured fact, an adjustment between production and consumption must needs come soon.

Prior to the year 1904 the greater part of the lighter grades of petroleum that are especially adaptable to the manufacture of the illuminating oils came from the Appalachian and the Lima-Indiana fields. For a number of years the combined production of the two fields has been remarkably constant. During the time between the years 1894-1903, inclusive, it has averaged about 55,500,000 barrels a year. During the year 1904 the Appalachian field showed a slight falling off in production as compared with 1903, and in 1905 a decrease in production of 6.5 per cent as compared with that of 1904. The Lima-Indiana and Illinois field held its production in 1904, but fell off 9.6 per cent in the year 1905 as compared with the preceding year, notwithstanding the fact that the 181,084 barrels of oil produced by the State of Illinois were added to the production of that field.

During the year 1904 the Mid-Continent field became an important factor in the production of the lighter petroleum. It added 4,250,779 barrels of oil during that year, not all of which, however, could be classed as of the lighter grades of petroleum. In 1905 the production increased to 12,013,495 barrels, with a much larger percentage of the better grades of petroleum. This increase from the new field more than offsets the decrease from the old territory, so that the total production of the lighter grades of oil during 1905 was fully 7,000,000 barrels above the average production for a number of years.

The consumption of illuminating oil from 1894 to 1903 slightly exceeded the production. The stocks held by the large pipe-line companies, which amounted to 33,772,823 barrels at the end of the year 1897, were reduced to 20,772,823 barrels at the end of the year 1903. During the year 1904 there was a consumption of 55,968,171 barrels against a production of 61,715,278 barrels, and in 1905 a consumption of 60,875,677 barrels against a production of 63,855,710 barrels. These two years caused an increase in the stocks held of 8,717,140 barrels.

It is probable that the current year will show a still greater falling off in the production of the Appalachian field than was experienced in 1905. The production from the State of Illinois will probably fully maintain the production of the Lima-Indiana and Illinois field, while all indications point to a very large production from the Mid-Continent field. Even with the maintenance of the large consumption of the year 1905, there is every indication of a strong increase in the accumulated stocks.

The completion of a pipe line from Humboldt, Kan., to Whiting, Ind., marks another step in the transportation of oil, and should be mentioned as an important feature of the year's achievements in the oil industry.

Persons desirous of having more detailed information concerning the production of oil during 1905 should ask for the Survey report, which is published for free distribution. It was prepared by Mr. W. T. Griswold, under the supervision of Mr. David T. Day, and is issued as an advance chapter from the annual volume entitled "Mineral Resources of the United States, 1906."

ELECTRICALLY-OPERATED TRAVELING PLATFORMS, TURNTABLES, AND WINCHES.*

By DR. ALFRED GRADENWITZ.

ELECTRIC motive power has found an especially interesting and extensive use in railway stations and railway workshops. Apart from a large variety of machine tools operated by electricity, either individually or in groups, electrically-operated traveling platforms, turntables, and winches should be given special attention, by reason of the evident advantage offered by electric power transmission as compared with steam, gas, compressed air, and other motive agents.

A few typical electrically-driven traveling platforms, turntables, and winches designed for the Potsdam railway workshops are described in the following and illustrated by means of photographs kindly supplied to the writer by the Siemens-Schuckert Works.

Fig. 1 shows the operation of two traveling platforms, each of which is actuated by an inclosed alternating current motor of 7.5 horse-power with 750 R. P. M. Each of these motors works on the driving gear through pairs of milled steel spur gears, the motor gearing running in an inclosed oil-case. The pinion of the second gearing is mounted on the transmission shaft originally provided for hand-operation and which has been extended conveniently. The traveling speed of each platform is about 20 meters (65.6 feet) per minute, a pedal-operated brake serving quickly to stop the traveling motion and the rope winch.

The motor of each shaft is controlled by the aid of a controller operated by a horizontal handwheel, which is the simplest and most practical system, a special advantage being the very easy direct operation of the controller and absence of any intermediary parts.

FIG. 1.—ELECTRICALLY-OPERATED TRAVELING PLATFORM.

Figs. 2 and 3 represent a turntable without toothed rim, being 18.2 meters (25 feet) in useful length, 30 tons in weight, designed for a useful load of 60 tons and operated by what is called a tractor, including a rotary current motor of 5 horse-power output, with a maximum speed of 950 R. P. M. This motor drives, through two pairs of milled spur gears, one of which runs in an inclosed casing, a traveling tractor, the traveling wheel of which runs on the circular rail of the turntable. The whole of the driving gear is located in a heavy cast-iron box frame, locked at the top by a sheet-metal screw cover and connected by a joint with the turntable. The attendant, standing on the turntable, operates the backward and forward controller of the traveling motor.

Current is supplied in the following manner: Contact lines, consisting of two annular conductor rails, are arranged round the foot of the frame. The rails are carried by insulators having fitted-on caps and convenient lateral fittings. Current is supplied through two underground lead cables, resilient brushes, fixed to an insulated girder, sliding on the rails and leading the current through cables to the motor and controller.

The electrically-operated winch represented in Fig. 4 serves to convey the cars to and from the turntable and to and from the shed. The gear of this winch is located entirely in a box, being fitted into the floor,

FIG. 2.—THE TRACTOR OF THE TURNTABLE.

The current is supplied to electrically-operated traveling platforms in the same way as to electrically-driven traveling cranes, the construction of which is in many respects similar to that of the former. Each traveling platform has a special overhead line, from which current is derived by a current collector to a special switchboard located in a protective iron cabinet. From this switchboard, including a cut-out and safety fuses, the current flows to the motor and to the controller for forward and backward traveling.

The wires are strung out at a convenient height above the traveling platform between insulators fixed to the walls of the hall. On the platform is placed a framework pole carrying at its top the current collectors.

Both the driving gears, the motor, and controller are protected by water-tight covers against any atmospheric influences, easy access being, however, insured to their various parts by valves in the protective casing.

while the rope drum (or "winch head," as it is called) projects above the platform.

The winch receives a tractive effort of 500 to 600 kilogrammes (1,100 to 1,320 pounds) with a minimum speed of the rope of 30 meters (98.4 feet) per minute, from a 6-horse-power rotary current motor. This motor transmits its power through an inclosed worm gearing, running in a locked oil box and thence through milled spur wheels. The motor starter is likewise

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

located in the winch casing, and is operated from above by a plug key.

The end of the rope, carried over several guiding rollers according to the direction of hauling, is wound up on a transportable drum.

THE TUNGSTEN LAMP.*

IN view of the recent important and interesting announcement that the General Electric Company is

FIG. 3.—TURNTABLE WITH WINCH.

going to manufacture tungsten incandescent lamps on an extensive scale and that its tungsten lamp consumes between 1 and 1¼ watts per candle it seems interesting to give in the following notes a concise review of what has been done in the past toward the development of this new lamp.

While tungsten is considered one of the rare elements, tungsten compounds are of considerable use. Sodium tungstate is largely employed for impregnating fibers to make them fireproof. It is also used as a mordant in dyeing. Tungsten bronzes are largely employed as bronze powders and pigments. The chief consumption of tungsten in recent years has been, however, for high-speed tool steels and for hardened steel for armor plates and large guns.

It is mainly on account of the rapidly increasing use in the steel industry that the demand for tungsten has shown a remarkable advance since 1900, as is indicated by the following figures, taken from J. H. Pratt's "Production of Steel-Hardening Metals in 1905" (published in SCIENTIFIC AMERICAN SUPPLEMENT): 46 tons of tungsten concentrates were produced in this country in 1900, 179 tons in 1901, 184 in 1902, 292 in 1903, 740 in 1904, 803 in 1905.

The value per ton has also advanced, due to the greatly increased demand. According to Pratt, whereas formerly tungsten concentrates containing 60 per cent WO_3 were valued at from $2 to $3 per unit, they are now worth from $5 to $6 per unit, and it is not improbable that a price of $6 per unit may be maintained. The word unit here means 1 per cent of a ton. In spite of this advance of price, it will be seen that tungsten is a rare element not at all in the same sense as, for instance, platinum or osmium.

At the present time there is but one district in the United States that is being developed as a business proposition and on a large scale, and that is the Boulder County, Colorado, district. There are, however, numerous localities throughout the United States where tungsten minerals have been found, but there are only a few thus far known that give promise of containing the metal in quantity. Only small quantities of ferrotungsten alloys or tungsten salts are imported into the United States, because at the present time the European markets utilize practically all of the tungsten that is produced in foreign localities, largely in Australia and Peru.

The melting point of pure tungsten has always been stated to be very high, though it does not seem to have ever been accurately determined. As a matter of fact, from experiments recently made with pure tungsten by Just and Hanaman (London Electrician, 1906, April 27) it appears that tungsten behaves like carbon, since (under ordinary conditions of pressure) it volatilizes directly without passing through the liquid state. But the temperature at which carbon volatilizes is considerably lower than that of tungsten. That means that a tungsten filament can be operated at a considerably higher temperature than a carbon filament, and from the thermo-dynamical laws of radiation, especially from the Stefan-Boltzmann law of total radiation and from Wien's displacement law, we can therefore conclude *a priori* that the tungsten lamp will be much more efficient than the carbon lamp.

In view of its well-known refractory nature, the use of tungsten for the filament of incandescent lamps early suggested itself, although the first attempts were rather to coat a carbon or platinum filament with a layer of tungsten. For the production of pure tungsten filaments different methods have been worked out in recent years, first by Dr. Alexander Just and Franz Hanaman, second by Dr. H. Kuzel, and third by the Welsbach Company, although by using the words "first," "second," "third" we do not mean to decide in any way questions of priority or superiority.

Like most metals proposed for incandescent lamp filaments, tungsten has a lower electric resistivity than carbon, and for this reason the manufacture of high-voltage tungsten lamps is more difficult than that of carbon lamps for the same voltage. The underlying reason of this difficulty is the same as with osmium and tantalum lamps, but from what will be said below it seems that in the main these difficulties in the manufacture of tungsten lamps have been successfully overcome.

To avoid any misunderstanding concerning the exact meaning of the figures given in this article, it should be said that with candle-power is always meant mean horizontal candle-power. Further, since the tests were made in Austria and Germany, the unit is the hefner candle, which was heretofore always assumed to equal 0.88 British or American candle-power. On this basis, when in the following, for instance, a consumption of 1 watt per candle-power is mentioned, it means 1 watt per mean horizontal hefner candle-power, which is equivalent to about 1.14 watt per British candle-power. From recent tests of the Reichsanstalt, dealt with in our issue of July 21, 1906 (page 115, and Digest, page 145), it appears, however, that the former usual conversion factor between hefner candle and British candle-power must be modified so as to make 1 hefner = 0.909 British candle-power or 1 candle-power = 1.1 hefner. On this basis a consumption of 1 watt per hefner candle is equivalent to 1.10 watt per British candle-power.

FIG. 4.—ELECTRICALLY-OPERATED TURNTABLE WITH WINCH.

The German patent 154,262 of Just and Hanaman, of Vienna (April 15, 1903, granted Sept. 8, 1904), starts from the idea of producing a coating of tungsten on a core of carbon. The oxychlorides of tungsten or molybdenum, when heated to red heat, are reduced by hydrogen, forming metal, hydrochloric acid and water. If, therefore, a carbon or metallic filament is heated to incandescence in an atmosphere of tungsten oxychloride vapor with an excess of hydrogen, the reduced tungsten is deposited on the carbon or metallic filament, and the resulting filament consists of a core of carbon or metal, with a cover of tungsten.

Experiments proved, however, that under certain conditions the reaction proceeds in a different way. If a carbon filament is electrically heated in tungsten oxychloride vapor in presence of very little hydrogen, it is by and by transformed into a filament of pure tungsten. The carbon is oxidized to CO and CO_2, the chloride combines with the hydrogen and the tungsten is deposited in the place of the carbon.

When the carbon has been entirely replaced by tungsten, it is advantageous to increase the quantity of hydrogen and more tungsten is now deposited on the tungsten filament, hydrogen being the reducing agent, while carbon does not participate in the reaction.

The conditions under which the reaction occurs with the oxidation of carbon are an excess of oxychloride, the presence of very little hydrogen and a high temperature of the filament. With an excess of hydrogen and at too low a temperature of the filament, carbon does not participate in the reaction.

Exactly the same reactions take place with molybdenum instead of tungsten.

In the Chemiker Zeitung of July 28 Dr. E. R. Boehm points out that this method is entirely analogous to a method patented by Dr. Fritz Blau in 1901 for transforming a carbon filament into osmium in an atmosphere of osmium tetroxide.

The above method is called the substitution method. Some modifications of the same are mentioned in the English patent 11,949 of 1905, granted to Just and Hanaman. When a carbon filament which is provided with a coating of tungsten of sufficient thickness is submitted in vacuo to an adequate temperature by passing an electric current through it, the carbon combines with the metal surrounding it and a carbide is formed, the whole filament now becoming homogeneous. This process, which may be termed "dissolving" the carbon, occupies but a few minutes, and takes place the more speedily the greater the excess of metal over carbon. In order to first produce the tungsten coating on the carbon, carbon filaments of the greatest possible fineness (of a diameter of, say, from 0.02 to 0.06 mm. to 0.8 to 2.3 mils) are submitted to the action of an electric current in an atmosphere of tungsten hexachloride W Cl_6 in the presence of hydrogen or of some other gas exercising a reducing action, whereby the tungsten is deposited upon the surface of the carbon. When the tungsten coating is of sufficient thickness, the filament is brought to incandescence by an electric current in an atmosphere of a very highly rarefied inert gas, such as hydrogen, at a pressure of 20 mm. The solving process, above described, then takes place and is completed in a few minutes. The filament thus obtained contains the carbon in a bound form (mostly as carbide) and presents a glittering white appearance.

The filament is once more raised to a high temperature by an electric current in a mixture of steam with reducing gases, and the carbon is oxidized by an action similar to that which takes place in the manufacture of water gas. (This, as may be remarked here, is exactly the same reaction by which the carbon due to the organic binding materials is removed from the osmium in the manufacture of the osmium lamp.) Another method of decarburizing described is as follows: The tungsten-carbide filaments are imbedded in a refractory crucible, which is then carefully luted, in a very finely pulverized low oxide of tungsten, as WO_2 and then heated to a temperature of about 1600 deg. C. for several hours. By this process the carbon is oxidized according to the equation $WO_2 + 2C = W + 2CO$. The reduced tungsten does not become deposited upon the filament, but remains in the oxide mass surrounding the filament as an amorphous powder.

Besides these substitution methods, an entirely different process has been patented by Just. It is called the paste method, and is analogous to Auer von Welsbach's method of making osmium filaments. Tungsten compounds, reducible by hydrogen (like oxide, sulphide, chloride, etc.), are powdered and mixed with a binding material free from carbon (such as water) formed into a paste, pressed into filament shape and reduced in an atmosphere of hydrogen.

It seems, however, that some substitution method is now used in practice for making tungsten lamps. The development of the tungsten lamp by the methods of Just and Hanaman took place in the lamp works of the Vereinigte Elektrizitäts A. G. in Ujpest, which owns the licenses for Austria and Hungary, Russia, Belgium, Italy, Spain, and Portugal. The German patents are owned by the Wolfram A. G. in Augsburg, which have transferred the monopoly of manufacture to Georg Lüdecke & Co. in Lechhausen.

According to a statement of the Vereinigte Elektrizitäts A. G. the substitution method of Just and Hanaman permits the manufacture of very thin fila-

* Electrical World.

ments of pure tungsten, whereby it becomes possible to make 110-volt lamps for relatively small candle-power, like 32 candle-power. It is stated that filaments with such a small diameter cannot be made by the paste process. In the 110-volt, 32-candle-power tungsten lamp of Just and Hanaman there are three exceedingly thin filaments of pure tungsten, the filaments being held in place by suitable stays of aluminium oxide or of a mixture of other suitable oxides. In size and form the new lamp is stated to be almost identical with the ordinary 110-volt, 32-candle-power carbon filament lamp.*

Concerning the results obtained with the Just-Hanaman tungsten lamp, no exact information is yet available. But the statement is made—apparently on the authority of the manufacturers—that the average life of a 110-volt, 40-candle-power lamp when consuming one watt per hefner candle is 1,500 hours. It is also claimed that the illuminating power of the lamp remains almost unaltered during its entire life, and that it is not at all sensitive to fluctuations in the supply pressure.

Another type of tungsten lamp has been developed by Dr. H. Kuzel, of Vienna, whose invention is based on two new essential features as pointed out by himself in a communication to Elektrotechnische Zeitschrift, of May 10, 1906. One point is the establishment of the fact that metals in the colloidal condition form plastic masses without the addition of a binding material and can be formed easily into colloidal wires. The second point is that wires formed in this way and dried undergo a physical change when subjected to strong heat; without breaking or disintegrating into powder they pass over from the colloidal state into the crystalline condition and the lamp filament is thereby finished. Dr. Kuzel claims that he can use this method for bringing a great many metals into filament form. In his patent he mentions fourteen, among them tungsten.

But this is not all. Dr. Kuzel is reported to favor alloys instead of pure metals, though the published information is extremely vague. If that material is most suitable for an incandescent lamp filament which has the highest melting point, it would seem *a priori* that a pure metal must be used. For it is a general rule, based on sound thermodynamics, that the addition of any impurity to a pure material lowers its melting point. (This is true under the condition that in the freezing liquid none of the foreign substance passes into the solid phase.) For this reason any first admixture of a foreign material to a pure metal filament like tungsten will necessitate operating it at a lower temperature. It is just for this reason that in the steel industry when we want to add chromium or tungsten or so to the molten bath, we add it in form of a ferro-alloy because this has a lower melting point than the pure metal. But the requirements of incandescent lighting are the reverse and for this reason it has been an axiom in the past that pure elements must be employed for filaments and much of the extended chemical research work which has been done in lamp factories was carried out for the purpose of devising methods of purification.

However, while it is true that the first addition of impurity (under the limiting condition given above) lowers the melting point of a pure substance, it does not follow that an alloy must always have a melting point lower than its constituents when pure. If the melting-point curve of two metals, A and B, is plotted in the usual way as function of the ratio of A to B, it will be found that the curve drops at both ends, i. e., the melting point is lowered if a little of the metal, *B*, is added to pure *A*, or if a little of the metal, *A*, is added to pure *B*. But there are cases known where the curve looks like this: Beginning at the left hand (pure *A*), the curve first drops, reaches a minimum, goes up again to a singular point which we may call *C*, drops again, reaches a minimum and rises again to pure *B*. And there are cases known when the melting point of the alloy corresponding to point *C* is higher than that of the pure metals, *A* and *B*. It is possible that Kuzel wants to use such alloys for filaments, though it is not clearly stated. Moreover, it is quite possible that the importance of a high melting point has been overestimated in the past, and that other physical properties (for instance, electric conductivity, etc.) are of greater importance for the construction of filaments.

The German patents of Kuzel are owned by Pintsch Brothers in Berlin, while in Austria the firm of Kremenecki in Vienna has already made Kuzel lamps. Results of tests of the same were given on page 354 of our last volume (February 17, 1906). They show a power consumption of about one watt per hefner candle, but the hope was expressed by the manufacturer that it might be reduced in future to one-half watt per hefner candle with a useful life of 1,000 to 1,500 hours. Nothing whatever was stated concerning the material of the filament.

Finally the work of the Austrian Welsbach Company must be mentioned. While very little information has been given out by them, they were among the first to place tungsten lamps on the market for voltages of 100 to 120 and consuming one watt per hefner candle. Their lamps have been tested in the testing laboratories of the Municipal Electricity Works of Vienna. The above figure for power consumption was confirmed and while the tests were not yet completed when referred to by Mr. Ross in a lecture before the Austrian Association of Electricity Works, the results obtained up to 1,000 hours of burning were said to be favorable. The hall in which this lecture was held was lighted with Welsbach tungsten lamps of 60 to 80 candle-power, giving a light which was specially pleasant by its beautiful white color. That these lamps are not sensitive to variations of voltage and can stand considerable overload, was shown by the lecturer, who operated one of the lamps at double the normal voltage. The only information on the Welsbach Company's method of making the filaments is that they treat the trioxide of tungsten with an excess of ammonia so as to form a tough paste and work this into filaments.

Quite recently the announcement has been made by the Welsbach Company that during the next season they will place on the market modifications of their osmium lamp, for which they use the trade names "osmin" lamp and "osram" lamp. They are employed at higher voltages than the osmium lamp, and are stated to have a much higher efficiency. According to Dr. C. R. Boehm (Chemiker Zeitung, July 28), the chief constituent of the filament of these new lamps is tungsten. The name osram is derived from osmium and wolfram (the German name for tungsten). Thus it seems that the Welsbach Company, like Kuzel, undertakes the employment of alloys for filaments.

Twenty-five-candle-power and thirty-two-candle-power "osram" lamps have been officially tested by the German Reichsanstalt (Elektrotechnische Zeitschrift, August 9, 1906), alternating current derived, if necessary, from the supply network of the Charlottenburg municipal electricity works being used for testing. The osram lamp consumes about 1 watt per hefner candle, the average life being 1,000 hours; during this life the loss of candle-power is almost insignificant, as will be seen from the following figures of the Reichsanstalt for "25-candle-power" osram lamps (which are more difficult to build than osram lamps for higher candle-power and the same voltage). The average alternating-current voltage was 117; the mean horizontal candle-power 28.5; the consumption 1.11 watt per candle-power at the beginning. After 200 hours the corresponding figures were 29.8 and 1.06, after 500 hours 28.1 and 1.12, and after 1,000 hours 26.6 and 1.18. These are the mean values for the whole set of lamps tested. The best lamp of the set gave 27.3 candle-power and consumed 1.10 watts per candle-power after 1,000 hours; the worst lamp gave 25.7 candle-power and consumed 1.22 watt per candle-power.

This is the first official test of any type of tungsten lamp which has been made public and it should be again emphasized that these tests were made with alternating current. It is claimed for the tungsten lamp in general that it works as well with alternating current as with direct current, but in the absence of official tests of other types of tungsten lamps, it is necessary to be somewhat cautious in accepting such claims in view of the experience with the tantalum lamp.

From the above summary of the development of the tungsten lamp in Europe it will be seen that it took place almost exclusively in Austria. This is probably to be attributed to the strong influence of Dr. Auer Ritter von Welsbach, the remarkable chemical engineer whose work has been of such immense importance in creating the methods of modern illumination, both in gas and electric lighting.

* It is stated at present that this company will select the 40-hefner candle (35.9-cp) 40-watt, 110-volt lamp as standard type.

DUSTLESS ROADS FOR MOTOR TRAFFIC.

THE information on the question of the improvement of roads contained in the report of the Royal Commission on Motor Cars, recently published, should enable the public to form some definite idea on the merits of a subject which has really become one of the important problems of the day. It is impossible for any one who has not lived on one of the principal country roads out of London to realize the positive curse—there is no other word for it—of dust caused by motor cars. The road question in regard to motor cars may be broadly divided under two heads: dust and speed, of which the former is by far the more serious. It is possible for pedestrians to keep out of the way of motor cars, however fast they travel, but there is no avoiding the dust the cars make. It may be said, indeed, that the only way to get over the nuisance is to render the roads dustless; for no modification in the construction of the cars will prevent them from raising dust when traveling at speed; though a low-bodied car, as compared to one built high, is worse in this respect, especially when there are downward-projecting parts under the bottom. It is the suction of the broad pneumatic tires that picks up dust, while the eddies of air caused by the passage of the body and the whirling spokes of wheels help to distribute it abroad; disk wheels and smooth high bodies would do much toward reducing dust, but would not eliminate it.

The report of Lord Selby's Commission states that on the great main roads, and within a radius of 30 or 40 miles of London, dust raised by motor cars "causes material damage, discomfort, and annoyance to users of, and dwellers by, the highways." One lady, an authoress, living near Guildford, said she hardly knew how to live in the house on account of the dust. It simply covered everything, indoors and out; it destroyed her flowers—even those under glass; it spoiled the fruit, and injured her health. She had inflamed throat, and her eyes were so affected that she could not pursue her work. A market gardener who also gave evidence before the Royal Commission said that the dust from motor cars destroyed the marketable value of produce on either side of the road. An estate agent at Ascot and Windsor said that herbage within 50 yards of hedges was absolutely useless either for feeding cattle or harvesting. In regard to the latter we have been informed that it is almost useless to attempt to cut grass for hay near a frequented motor road, owing to the knives becoming so soon blunted by the gritty dust. Specific cases of the deterioration in the value of property were given before the Royal Commission by Mr. Mason. In one case near Windsor a house that was bought for $25,000 could not be used owing to the dust, and was sold for $10,000. The person who bought it, thinking to make money by the bargain, could not, however, sell the house at any price. A farmer stated that hay and grain crops were rendered injurious to live stock, and cattle would seldom graze on pasture near the roads. These are a few among the many cases that might be quoted; and reference was also made in the report to a large number of resolutions from local authorities complaining of the dust nuisance, and calling for a remedy.

No doubt a good deal that is said on this subject proceeds from those who are hostile to motor cars; but when every allowance is made for exaggeration, there is no doubt that motor car dust has become a nuisance of the first magnitude.

The speed question and the dust question are, of course, interdependent, for it is only at high speed that an excessive amount of dust is raised. If motorists were content to travel at the pace of horse-drawn vehicles—say, 10 or 12 miles an hour—there would be no cause for complaint. This, the motorists tell us, is "putting back the hands of the clock"; motor cars "have come to stay," and to drive them at only the speed of an ordinary carriage or stage would be to destroy the object of their existence. These arguments have to be accepted, and a remedy must be found for the dust nuisance by making dustless roads.

One of the difficulties is to get over the transition stage, as is usually the case at the inception of a new era. If we had to deal with motor cars alone, a good deal might be done that is difficult to accomplish with mixed light and heavy traffic of horse and mechanical traction. A surface that would last well when subjected only to pneumatic tires is rapidly broken up under the impact of the iron-shod hoofs of horses, or the metalled tires of heavy vehicles; and if there were no horse droppings, the most objectionable source of dust would be removed. The report of the Royal Commission favors the best type of macadam for all kinds of traffic, including heavy and light motor cars. Such roads we know by experience are by no means dustless, though, of course, they are more nearly so than those composed of a local stone of a more friable nature, such as is often used under the mistaken idea of economy. It may be said, however, that the latter kind of roads often give an easier surface than the modern macadam, or what goes by that name in the present day. The report says that macadam roads "should be made with solid foundations and surfaced with granite or similar hard stone, the binding material being of screened gravel, or chippings of the stone used, and properly rolled in."

For roads carrying exceptionally heavy traffic a more costly pattern of road should be employed, and the system of "armoring" a metaled road surface with stone blocks is recommended. This system, known as the Kleinpflaster, is used with success in Northern Germany, and has been described by Capt. Bigham. The foundation consists of inverted pyramidal large stones of from 4 inches to 8 inches square by about 7 inches high. Above these, and into the interstices between them, small broken stone is packed to a height of 4 inches to 5 inches, the whole being consolidated by rolling or ramming. Above this, sand is laid to a depth of 1 inch, and again above the sand are placed carefully selected broken stones, of basalt for preference, of about 3½ inches to 4 inches square, and from 3 inches to 4 inches deep. These are placed close together, rarely more than ½ inch apart, and a lime-sand binding of a heavy consistency is used. It is said that "the crust so formed is practically as flat and regular as one of macadam;" by which we presume is meant modern macadam, which is by no means flat and regular, with its admixture of so-called "binding material." It is also stated that "the sand binding forms into a kind of mortar, and does not disintegrate, and the roads have thus been found to be practically dustless."

Whether this dustlessness would endure under the conditions of a mixed traffic of very heavy vehicles, such as mechanical traction has introduced, and pneumatic-tired motor cars, we are not aware; but it would seem that the binding sand might be crushed between the top sets by the heavy traffic, and be drawn up in the form of dust by the suction of the pneumatic tires. In any case, a carefully constructed road of this nature must be costly, but against this may be set the fact that it is durable. The life of these roads is from about twenty-five to thirty years, and they then only need surface relaying. The first cost of a new road is stated to be about $1.75 per square yard, or $16,165 a mile for an 18-foot road. The cost for labor is 65 cents per square yard; it would doubtless be more in this country. Such upkeep as is required is estimated at $220 a mile annually. If an old foundation were used, the first cost would be $12,645 per mile.

France, since the days of Napoleon, has been celebrated for the excellence of her roads, and some of the finest highways in the world are to be seen in that country. The *routes nationales* are supported entirely by the state, unless, in exceptional cases, a contribution is made by those local authorities who ask for some special feature. There are—or were in

1904—about 23,820 miles of these national roadways, and of this about 1,372 miles were paved; the remaining 22,448 miles being metaled. The expense of maintaining these roads amounts to a little over $250 a mile per annum, without including the construction and maintenance of large bridges. The *routes nationales* are never less than about 20 feet broad, and often exceed this width, and have raised footpaths on each side. Local material is used whenever possible, though a certain amount of imported stone is employed. Steam rollers of from 20 to 30 tons are used.

The paved roads (*route pavée*) have a sand foundation about 6 inches deep, over which are laid setts from 5½ inches to 8 inches long by 7 inches to 8 inches deep. The sand foundation is not rammed, so as not to destroy its elasticity, and sand is used for binding. The life of such a road should be from forty to fifty years, and its initial cost is calculated at about $32,000 per mile. The yearly upkeep per mile is from $150 in the provinces to $1,450 in the Department of the Seine; the average for paved roads in France being $240 per mile per annum. There are a few hundreds of miles of a more expensive type of paved roads, where traffic is exceptionally heavy.

The greater proportion of these French roads are, as will be seen, of the metaled type; and on some an experiment has been tried which is of especial interest in connection with our present subject. What is known as the *route goudronnée* has recently been constructed by way of experiment. The road is laid exactly like an ordinary metaled road, but after the final rolling, and subsequently once a year in the summer, ordinary liquid tar heated to about 160 deg. F. is spread on the dry and carefully-swept surface, at a rate of about two pounds to the square yard. The road is then left free from traffic for a day or two, so that the tar may harden. The cost of this, with tar at about $10 per ton, works out at about 2½ cents per square yard, the labor costing double the material, and involving a further yearly expense of $225 a mile on an 18-foot road; but there is an offset of at least $20 a mile in the saving on watering. Capt. Bigham reports that this method of tarring roads has been found very satisfactory, as it almost entirely suppresses dust, the tar forming a species of upper crust, which preserves the road from disintegration.

This method of tar-dressing has been experimented with in the Department of the Seine, where the traffic is generally of a more trying description than that of the provinces; but whether the experimental length was subjected to heavy traffic, as understood, say, in the county of Kent, we are not aware. Whether the modern traffic of this country, due to traction engines and other very heavy vehicles, would not prove too trying for the tar crust is a matter that may be well open to doubt. In any case, as was stated at York, when Mr. Douglas Mackenzie read his paper on road construction before the British Association, the remedy of tarring ordinary roads has proved almost worse than the disease. At first those living in the neighborhood are delighted with the absence of dust; but after a time they find King Log has been deposed only to install King Stork. After the tar-dressing has been applied for some time a certain amount of dust begins to appear, and this is of so pernicious a nature, being partly particles of tar, that all textile fabrics are speedily reduced to a uniform dirty-gray color, which no amount of washing will remove. In wet weather, also, the very tenacious mud, that is invariably brought into the house on the boots of pedestrians, ruins carpets, mats, etc., and if any gets on clothing it quite spoils the material. Tar-mud also is said to be very productive of side-slip for motor cars. On the whole it would appear that the application of tar to ordinary metaled roads has not been so successful in this country as it is said to have been in France. Whether that may be because we do not apply it so effectually as our neighbors is a matter that might be inquired into with advantage.

In England tarring roads has been tried to some extent as an experiment, but without any great measure of permanent success, especially if applied to dusty roads; indeed, one of the chief necessary points to observe, if the application of tar is to be a success at all, is that it should be used only on roads formed of good hard metal; to apply it to limestone or flint roads is worse than useless. Mr. Stallard, the county surveyor for Oxfordshire, has stated that tarring a mile of road would cost $300, while the upkeep would be about another $300, and it would not then last very long. He therefore objected to tarred macadam, if only on the score of expense. Mr. Crichton, the honorary secretary of the Roads and Traffic Reform Association, places the cost of tarred macadam with foreign material at from 88 cents to $1.00 a yard. Mr. Humphreys gives the cost as $20,000 a mile for a 30-foot road. Mr. Pain, of the Highways Committee of the Surrey County Council, gives the price of ordinary tarring as 5 cents per square foot, and "tarmac" at 75 cents to $1 a yard. Mr. Bean, county surveyor for Northumberland, says that tarred stone costs 30 per cent more than ordinary broken stone; while tar-macadam, by which, presumably, is meant "tarmac," is dearer still. He was of opinion, however, that the latter would not be more expensive than ordinary macadam, as it would last longer.

A good many special substances, about the composition of which there is generally much mystery, have been introduced as a remedy for dust. Perhaps the most often heard of has been that known as "westrumite"; but the great hopes founded on its introduction have not always been fulfilled. Lord Montagu of Beaulieu, in his evidence before the Royal Commission on Motor Cars, said that as a palliative for a particular purpose on a particular day—such as a motor-car race—it answered admirably; but he thought it a waste of money to apply it on a big scale to the main roads of the country; while one district surveyor told the Commission that it was impossible to apply substances of this nature on a wholesale scale, as it was necessary to take account of the weather. Mr. Maybury, the surveyor for the County of Kent, had used about $3,000 worth of westrumite, and also a patent chemical called "dustroyd." He had, however, to abandon the latter because the council was threatened with an action for damaging vehicles and polluting streams. Another witness said he had used westrumite, and though it was very nice for a short time it was soon gone, and he did not think it worth using. "Tarmac," already referred to, is another material that has been used, apparently at times with success. It consists of blast-furnace slag boiled in tar. A trial made in Guernsey, where, however, the motor traffic can hardly be very heavy, is said to have given excellent results. A length laid at Croydon lasted under heavy traffic longer than tarred macadam but cost 30 per cent more than granite road. We believe it has also been tried with encouraging results elsewhere.

One of the most recent candidates for favor as a dust preventer is a liquid known as "hahnite." A length of macadam road, of about ¾ of a mile, between the "Dysart Arms," Petersham, and Ham Common, has been treated with this material; and Londoners have therefore an easy opportunity of judging of its effect for themselves. What the material is exactly has not been made public; but from inspection and smell we should judge it to be composed of a mineral oil refuse, and we understand that tar and disinfectants enter into its composition. At any rate, it has the effect of giving a good surface to the macadam, and the length that has been so treated is really dustless. The cost of hahnite is $35 a ton, and 2 tons were used for a first application on the ¾ mile of 22-foot road, while the labor is estimated at $5. It is calculated, however, that the cost of the material and labor is more than covered by the saving in watering, which would not be required on a dustless road. Whether the mud from such a road—although doubtless it would be present in smaller quantities than on an ordinary road—would be injurious to panels of carriages, to carpets, clothing, and textile fabrics to such an extent as to negative its use, would be a matter for inquiry; certainly in the dry weather, when we examined this length of roadway, it was much superior to the ordinary road, and, as we have said, was dustless.

We have not space to discuss the many other substances that have been brought forward as dust preventers. Generally, it may be said that none has been proved a permanent and unqualified success, although there may be excellent possibilities in more than one; and indeed some, such as the tarred blast-furnace slag, or tarmac, are spoken of most hopefully. The dust problem is, however, of such national importance that the government might well set apart a sum of money enough for experiments sufficiently exhaustive to enable some conclusion to be reached. The revived importance of our common roads, either for passenger traffic, goods transportation, or pleasure purposes, owing to the introduction of self-propelled vehicles, makes it imperative that attention should be given to their improvement.—Engineering.

Correspondence.

THE CONSTRUCTION OF THE HEAVENS.

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

The perusal of an article on the "Construction of the Heavens," by Hector Macpherson, Jr., published in a recent issue of your valuable paper, has led me to express some views on this and kindred topics. It is manifestly beyond reason that opinions on such transcendent subjects as creative law and the relations of what are termed external universes should have more than a speculative value; but it is the purely speculative character of all such opinion that would seem to justify a word from the laity, whose knowledge comes at second hand, as well as from those so fortunate as to be personally engaged in research and observation. Doubly justified would such suggestion be if founded on already established facts, and from them, through a belief in the unity and continuity of natural law, pointing out some possible fallacy or novel line of speculation.

In the closing words of Mr. Macpherson's quotation from Mr. Gore we find the following: "Could we speed our flight through space, systems of a higher order might there be unfolded to our view, compared with which the whole of our visible heavens might appear like a grain of sand on the seashore, systems perhaps stretching out to infinity before us, and reaching at last the glorious 'mansions of the Almighty,' the Throne of the Eternal."

Now, it is an interesting if not amusing thing to note in the history of theology what might in all reverence be termed the periodic displacement of the Throne of God, this displacement being a direct function of man's progress in physical and astronomical knowledge. To the ancient Greek the cloud-capped summit of Mount Olympus was a point remote enough and sufficiently clothed with mystery for a violation or supersedure of the natural phenomena which he saw transpiring about him. Because it was remote and mysterious it was the scene of supernatural activity—the abode of Jove. To the early Christian and Hebrew mind the idea of an earthly abode for the Deity was untenable, and there was assigned to Him a habitation above but by no means immensely removed from the earth. In at least three languages affected by the early Christian idea the word signifying the visible universe above and about the earth also designates the abode of Deity.

Passing without comment the many varied opinions in this phase of philosophy, we come at last to the progressive but devout astronomer such as Mädler, who, in the midst of his profound investigations, does not forget his God, but would give to Him a local habitation if not a name, the distance at which this habitation is placed being not disproportionate to the man's attainments in knowledge of the universe. It is on a star immersed somewhere in the depths of our own sidereal system. And now comes Mr. Gore with his hypothetical heaven not less than 520,149,600,000,000,000,000 miles or ninety million of light years removed! If the remoteness at which we place the supernatural is an index to progress in knowledge of things material, then the advance is truly marvelous.

The past decade of research has emphasized, in a way peculiar to itself, the unity of matter and the continuity throughout the universe of those natural laws which prevail under conditions already familiar. In the light of this, the assumption or admission that at some point, be it ever so remote, natural law is superseded by the supernatural is, to say the least, unscientific. On the other hand, the most recent advances in research have revealed a probable similarity between the infinitesimal units of matter and the units of our sidereal system that suggests a line of speculation which, without departing from already well-established laws, might lead at last to some definite conception as to the order and function of those vast external universes which we are led to believe lie beyond the power of telescopic vision.

The existence of an external universe is, to be sure, a matter of conjecture; but when the theorem of moment of momentum is taken into consideration in connection with the known tendency of the stars to crowd toward the galatic plane, it would seem to indicate, although it by no means proves, that the sidereal system is suffering a loss of total energy. Such a loss would imply the existence of an external system, the recipient of our vanishing energy, and an intervening media capable of its transmission. The extinction of light from such a system might be due, as Mr. Gore suggests, to the remoteness of such a system, or, according to Schiaparelli's theory, to the existence of material particles in interstellar space.

Mr. Frank H. Bigelow in discussing in the Monthly Weather Review the cause of solar magnetism, has pointed out the great similarity between the probable vortex motion of negative ions in the upper region of the sun's atmosphere and the whorl of negative electrons now conceived by physicists to constitute the essential mechanism of the atom. In other words, his argument tends to show, and with considerable force, that the sun is a colossal atom. He has also shown that this vortex motion has a direct connection with the phenomenon of sunspots. Elsewhere* it has been shown that other self-luminous bodies in the heavens are subject to the same disturbances that produce solar spots. From this we may conclude that the number of atomlike bodies existing in our sidereal system may extend into the millions. Profs. Newcomb and Young give the probable number of visible stars as one hundred million.

Let us now see if there is any arrangement in the sidereal system which will correspond to the grouping of atoms to form the molecule.

Stewart and Baley,† working in the laboratories of University College, London, on the question of "steric hindrance" in certain organic compounds, have come to the conclusion that in these substances the free paths of the atoms in their intra-molecular vibration are very large in comparison with their size. From this it would follow that the relation of the self-luminous bodies in forming the sidereal molecule would not necessarily be an intimate one. In fact, such a loose relation among groups of visible stars has already been pointed out. In this connection I can do no better than to refer the reader to the tenth chapter of Mr. Gore's most interesting and excellent work, "The Visible Universe." It would seem that a majority of well-known observers are agreed that stars are grouped with considerable regularity, a regularity which cannot be explained on the ground of mere accident. Not only is this a relation of situation, but a study of the proper motion and spectra of the stars shows that, in at least many cases, the members of the same group are moving in the same direction, and with a similar velocity.

M. Poincaré,‡ former president of the French Astronomical Society, has shown that, taking the self-luminous bodies of the universe to correspond to the molecule, we may, from a theoretical standpoint, consider the sidereal system as a gas obeying the laws that govern gaseous bodies, but that this gas, owing to the great distance between its molecules, is in a condition resembling Crookes's fourth state of matter. It can, however, be shown that if the self-luminous bodies are taken to correspond to the atom and the star group to the molecule of a somewhat complicated gas, we have the sidereal system more nearly resem-

* Walter S. Adams, in the Astrophysical Journal, September 1906.
† Astrophysical Journal, September, 1906.
‡ Popular Astronomy, September, 1906.

bling conditions of matter familiar in the organic world.

In conclusion: there are reasons for believing that the number of luminous heavenly bodies is far in excess of those visible to our most powerful telescope; these bodies and their groups bear a striking resemblance to the units of structure—the atom and molecule—of organic compounds with which we are already familiar. These sidereal atoms and molecules are probably bathed and inter-connected by the same ether that sustains the inter-atomic and inter-molecular relations. Is it too much to conjecture that the ultimate function of these stupendous systems is the organization, according to natural law, of a well-nigh infinite being or race of beings capable of self-consciousness and reason? CLARENCE EASTMAN.

St. Paul, Minn.

NEW CITRUS CREATIONS OF THE DEPARTMENT OF AGRICULTURE.*

By HERBERT J. WEBBER and WALTER T. SWINGLE.

AN examination of the manner of origin of the various native sorts shows that in almost all cases they originated as accidental seedlings. Some growers made hybrids and used systematic methods of breeding, but the number of fruits which have originated in this way are very few indeed. The long time required to bring seedlings to bearing, the cost of cultivation and manuring, and the uncertainty of results have deterred growers from experimenting very extensively in this field.

In much of the hybridization and breeding work which has been carried on by different investigators little attention has been given to the choice of the varieties used as parents and to the objects sought in the experiments. The time of this haphazard work, however, is past, as experience has demonstrated that it is far better for the experimenter to have a definite object in view and to select, as parents for hybridization, varieties which possess the characters that it is desired to combine in the hybrid. In the present experiments the following were the primary objects sought: (1) Hardier varieties which would endure the occasional severe freezes which visit the orange sections, and, if possible, varieties sufficiently hardy to be grown farther north than the present citrus belt; (2) new fruits having the loose, easily removable rind of the mandarin and tangerine combined with the quality, flavor, and size of the ordinary sweet orange; (3) new fruits having the sprightly acid flavor of the pomelo with the bitterness reduced, and the loose, easily separable rind of the mandarin and tangerine; and, (4) new fruits intermediate between the pomelo and the orange which would possess desirable market qualities.

In attempting to improve citrus fruits in hardiness, two methods present themselves. One method would be to grow a large number of seedlings and select from them the individuals which possess the greatest degree of hardiness, and continue this selection throughout numerous generations in the hope of augmenting any greater degree of hardiness that might be discovered. To pursue this policy with citrus fruits would require so long a period to secure any marked results that the method is impracticable. This is shown by the fact that for many years citrus growers have been making selections based on the hardiness of seedlings, and as yet no appreciable advance has been made in this direction.

A second method would be to select some hardy wild or cultivated type and cross this with the sweet orange or lemon in the hope of obtaining good varieties, combining the hardiness of one with the good fruit quality of the other. If such a hardy type exists, this method would certainly seem to be the quickest and most practicable way of securing hardy varieties. A species of citrus known as the trifoliate orange (*Citrus trifoliata*) is such a hardy type, which can be grown without protection as far north as Philadelphia. The common variety of the trifoliate orange was introduced into this country by the late William Saunders, of the Department of Agriculture, in 1869. The tree is small and bushy and very spiny, and the leaves are trifoliolate and deciduous. It is quite commonly grown as a lawn tree in the North and as a hedge plant in the South, while in the colder sections of Florida it is used as a hardy stock on which to bud the common orange and other citrus fruits. The fruit is round and small, ranging from 1¼ to 2 inches

RUSK CITRANGE TREE.

in diameter, and is orange-colored. The surface is covered with minute fuzzy hairs and is in most cases smooth, being rough only in the larger and more vigorous specimens. The rind, which adheres tightly, is about one-sixteenth inch in thickness. The pulp is acrid, bitter, and gummy, and the enormous number of seeds leave little room for pulp. The fruit is thus

MORTON CITRANGE. (¦ NATURAL SIZE.)

worthless as far as edible qualities are concerned. It is highly aromatic and attractive in appearance, making the plant desirable for ornamental purposes. Unfortunately, however, for its use in the South, the tree is deciduous, losing its leaves in the fall, and in general throughout this section an evergreen hedge is most desired. Notwithstanding this, it is generally cultivated as a hedge plant because of other qualities which make it desirable for this purpose. Its hardy character, however, is the factor of importance in connection with the experiments in the production of a hardy orange.

A second variety of the trifoliate orange, having rather larger leaves and very large flowers, has been found growing in several places in Washington, D. C., but has not been used in the present experiments.

The first variety described, the ordinary trifoliate orange, was the one used in the work of the writers, though the second might be more promising to use with the lemon, and some of these crosses have been made. However, no fruits have thus far been obtained. All varieties of the trifoliate group are deciduous, and ripen their fruit early in the fall before frost. They are also late in blooming in the spring, the flowers, which appear before the foliage, not even showing until the common sweet orange is nearly through blooming. The trifoliate is thus about two to three weeks later to start growth in the spring, and is never caught by late frosts. The early ripening of the fruit in the fall, moreover, allows the tree to become dormant at a time much earlier than the common sweet orange, which is evergreen and inclined to grow more or less through the winter during warm periods.

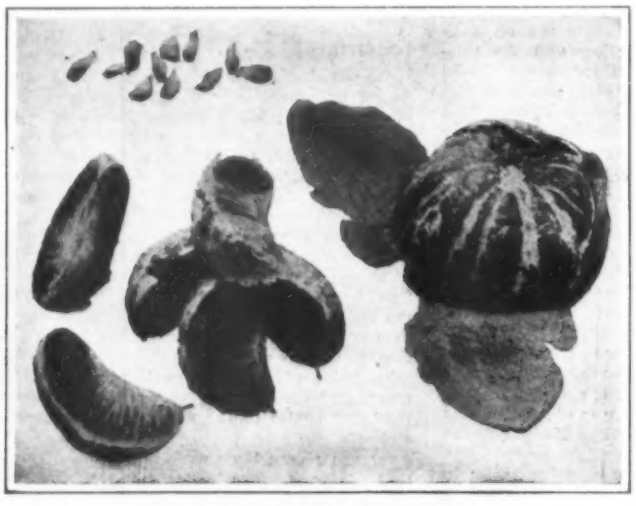
It is a well-known principle in plant breeding that in hybridization the characters of races and species break up and become combined in different ways in the hybrids. It would thus seem entirely probable that by crossing and recrossing the common orange with the hardy trifoliate orange a hybrid could ultimately be obtained combining the desirable fruit characters of the former with the hardiness of the latter. Many instances are recorded where hybrids have been obtained combining certain characters of the parents, and a few cases are known of hybrids which are intermediate in character of hardiness between the parents, being more tender than one parent and much hardier than the other. The improbability of obtaining the hardy quality in an orange variety is thus not so great as one might be inclined to think. If, by infusing the blood of the trifoliate orange into the sweet orange, we can modify the season of growth of the latter and cause it to remain more dormant during the winter and later into the spring, our object would be accomplished. If, on the other hand, a hybrid can be secured having an entire segregation of the characters and combining the hardiness of the trifoliate with the superior fruit qualities of the sweet orange, a far greater success would be achieved.

In the course of these experiments two fruits have been produced which are hybrids between the common sweet orange and the trifoliate orange, and which promise to be of considerable value. They lie about midway between the two parents, but are not sweet oranges, trifoliate oranges, nor lemons, and are totally different from any other group of citrus fruits. It therefore becomes necessary to refer these hybrids to a new group of citrus fruits, and it is proposed to call them "citranges," a term made up of the first syllable of the word *citrus* and the last syllable of the word *orange*. The two varieties which are to be referred to this group are described in detail below.

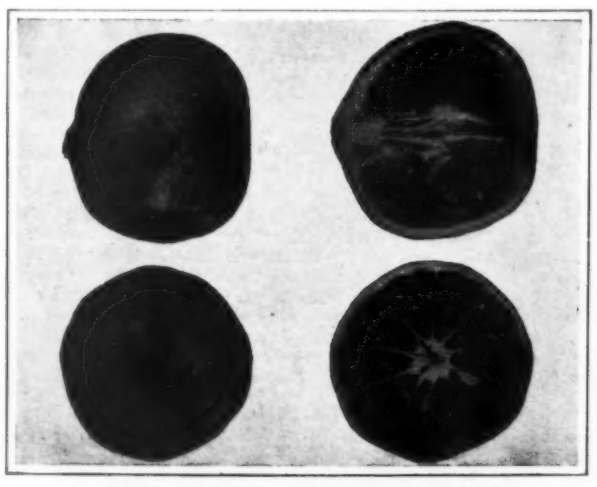
RUSK CITRANGE.

NAME AND ORIGIN.—The Rusk citrange originated as a hybrid between the common orange (used as the female parent) and trifoliate orange (used as the male parent). The trees are far more hardy than the common orange, and produce a fruit intermediate in qualities between the two parents. This being the first hardy orange or citrange produced, and belonging to an entirely new group of citrus fruits which will doubtless become of very great importance in many parts of the world and be improved in a marked degree, has been named the *Rusk*, in honor of the first Secretary of Agriculture, Hon. J. M. Rusk, under whose administration the first work on citrus fruits in Florida was undertaken by the Department of Agriculture.

DESCRIPTION OF FRUIT AND TREE.—Fruit compressed-spherical or nearly round; small, 1½ to 2 inches in diameter, 1¼ to 1⅝ inches high; color, when fully ma-



TANGELO. (MUCH REDUCED.)



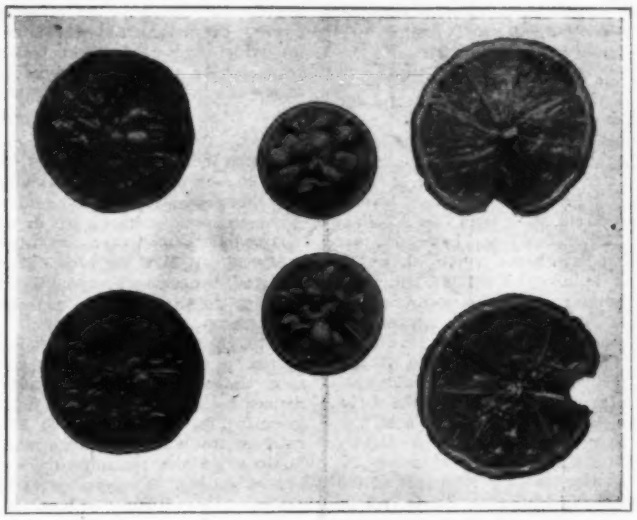
SAMPSON TANGELO. (MUCH REDUCED.)

ture, deep orange, with reddish flush of cadmium orange at apex; surface smooth and glossy, with a few scanty hairs visible under magnification; very heavy, frequently sinking in water; calyx persistent, green, rather larger than that of the ordinary orange; skin adhering very close to the fruit, thin, 3-32 to ⅛ inch thick, tender; oil glands small and round; pulp tender,

* Abstract from the Yearbook of the Department of Agriculture.

melting, exceptionally juicy; color orange yellow; pulp cells small, similar in shape to those of ordinary orange; segments, 10; membranes thin and tender,

WILD TRIFOLIATE PARENT.



CITRANGE. IN CENTER, WILD PARENTAL VARIETY.

thus making very little rag; axis small, 1/8 to 3-16 inch in diameter; flavor sprightly acid and slightly bitter; nearly seedless, averaging one seed to two fruits; aroma strong and pleasant, a combination of that of the sweet orange and the trifoliate orange. Tree similar in shape to trifoliate orange, vigorous and hardy, evergreen or semi-evergreen, tall and shapely; foliage dense, leaves trifoliolate and larger than those or ordinary trifoliate orange. Season of maturity very early, from September 1 to November 1.

The fruit of the Rusk is a beautiful little orange of excellent texture and exceedingly juicy. It is rather too sour to be eaten out of hand, but with sugar is very palatable. The bitterness is no more pronounced than in the grape fruit, and the aroma, which is derived largely from the trifoliate orange, is very strong and pleasant. The fruit of the Rusk may be utilized for making citrangeade, similar to lemonade or limeade, or may be eaten with sugar as a breakfast fruit. It also makes excellent pies, preserves, and marmalade, and may be used for general culinary purposes.

WILLITS CITRANGE.

NAME AND ORIGIN.—The second citrange which has given evidence of value has resulted from a hybrid of trifoliate orange with pollen of the common orange, being thus what is known as a reciprocal hybrid of the Rusk citrange. In general it possesses characters intermediate between the two parental varieties, and is similar to the Rusk in tree and fruit characters, yet differing considerably in detail, so that there is no trouble in clearly distinguishing it from the Rusk citrange.

DESCRIPTION OF FRUIT AND TREE.—Fruit compressed-spherical, or nearly round; small, from 1¾ to 2⅜ inches in diameter, and from 1½ to 2 inches in height; color from cadmium yellow to orange; surface rough with deep depressions over the largest oil glands, and with more or less pronounced furrows or ridges running from base to apex; weight medium, about the same as water or somewhat lighter; calyx persistent, with large and fleshy lobes; rind thin, ⅛ inch in thickness, and tender, not adhering so close to fruit as in the Rusk citrange; pulp translucent, light lemon yellow, resembling the ordinary lemon; segments 6 to 10, separated by thin, tender membranes; texture of fruit very tender, being equal to that of the best lemon; axis small, about ⅛ inch in diameter; flavor sprightly acid, similar to lemon, with very slight bitter taste of trifoliate orange; nearly seedless, averaging about one seed to four fruits; aroma mild and pleasant, combining the aromatic resinous odor of the trifoliate orange with the very delicate odor of the common orange. Trees similar to trifoliate orange, vigorous and hardy, evergreen or semi-evergreen, medium height and shapely; foliage dense, leaves trifoliolate and larger than those of the ordinary trifoliate orange; season of maturity very early, from September to the last of November.

The Willits citrange makes a beautiful, vigorous-growing tree and gives evidence of being of value as a decorative or lawn tree. The fruit makes a fine drink similar to lemonade or limeade and will be found pleasant as an acid fruit to eat with sugar. It is an excellent substitute for the lemon to serve with fish or oysters and is valuable also for culinary purposes, for which its seedlessness renders it specially desirable. The products made from the Willits citrange are very different in flavor from those made from the Rusk citrange. They possess more nearly the character and flavor of those made from the lemon.

HOW HARDY IS THE CITRANGE?

All the different citrange seedlings were budded on trifoliate orange stocks at Glen St. Mary, in northern Florida, in the spring of 1899. In January of 1900, when the buds were about eight months old, a severe freeze occurred in which the temperature went down to about 15 deg. or 18 deg. F. Mr. Taber recorded a temperature of 18 deg. above zero at Glen St. Mary. At Macclenny, Fla., 3 miles east of Glen St. Mary, a minimum temperature of 15 deg. was recorded, while at Lake City, about 20 miles west, the minimum temperature recorded was 17 deg. F., the record at Macclenny and Lake City being made by voluntary ob-

RUSK CITRANGE. (MUCH REDUCED).

servers of the United States Weather Bureau with specially corrected instruments. After this freeze a report from Mr. Taber stated that the foliage on the buds of Rusk (No. 716) and Willits (No. 777) citranges still remained green on the tree, and that the tops were apparently entirely uninjured. All of the hybrids between the trifoliate orange and the common orange which show intermediate characters also remained uninjured and retained their foliage fresh and green, with the exception of an occasional twig which at the time of the freeze was soft and immature.

In this freeze ordinary oranges suffered severely, large buds in many parts of the State being frozen to the ground, and this was the case with ordinary orange buds growing immediately beside the citranges at Glen St. Mary. Although no freeze which has occurred since has been so severe, temperatures of from 20 deg. to 23 deg. have been several times recorded. In none of these freezes have the citranges been injured, although buds of ordinary oranges have frequently been severely damaged.

Aside from tests made at Glen St. Mary, Fla., sets of the hybrids which had been made with the idea of producing hardy varieties were sent to the Florida, Georgia, South Carolina, Alabama, and Louisiana experiment stations to be grown and tested in co-operation with the Department of Agriculture. These were planted in March, 1900. At the experiment station at Lake City, Fla., which is about the same latitude as Glen St. Mary, the trees have passed through the winters since March of 1900 without serious injury. Here the trees have been grown under the direction of Prof. H. Harold Hume, who reports that the temperature has several times fallen to a point where all ordinary orange trees were severely injured or killed without resulting in injury to the Rusk or Willits citranges or to the other hybrids of intermediate nature. Prof. Hume reports that the minimum temperature recorded during this period was 21 deg. in December of 1901.

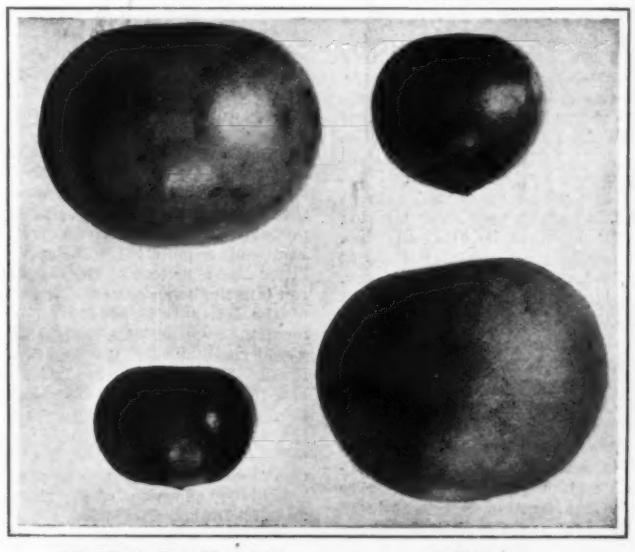
At the Georgia experiment station a set of the trees has been tested under the supervision of Director R. J. Redding and Prof. H. N. Starnes. At this place the temperature fell in February, 1901, to 17 deg. F. above zero, and in December, 1901, to 8 deg. The majority of the intermediate hybrids passed through these freezes without serious injury. The Rusk citrange was killed back to some extent, but lived through, and is now reported to be in good condition. The trees of the Willits citrange planted at this station have died, but whether directly from the effects of the cold is not certain.

At the Alabama experiment station, Auburn, Ala., a set of the trees has been grown under the supervision of Profs. Earle and Mackintosh. At Opelika, Ala., about 10 miles distant, the lowest temperature recorded, since the trees were planted, was 9 deg. F. above zero in December, 1901. Trees of the Willits have remained uninjured, while trees of the Rusk citrange are all reported as dead. Here again, however, it is not clear from the records whether they died as a result of injury from freezing, although this might be assumed. However, almost all of the strictly intermediate hybrids have survived the winters at this place without serious injury.

At the South Carolina experiment station, Clemson College, S. C., a number of the hybrid trees have been grown and tested under the supervision of Prof. C. C. Newman. Unfortunately a complete set of the hybrids was not sent to all of the co-operating stations, owing to a lack of trees of certain numbers. It happened that neither the Rusk nor the Willits citrange was among the number sent to the South Carolina station. However, a number of the intermediate hybrids similar to the Rusk and Willits citranges have been grown and tested at this station, and have passed through the winters since March, 1900, without serious injury. At this station they have endured a minimum temperature of 6 deg. F. above zero, which occurred in December, 1901.

At the Louisiana experiment station a set of the hybrids, among them the Rusk and Willits citranges,

TANGELO. TANGERINE.



HYBRID FROM SEED OF SAME. POMELO. (MUCH REDUCED.)

have been tested under the immediate supervision of Dr. W. C. Stubbs. At this station the temperature in December, 1901, fell to 21 deg. F. above zero, and remained below 26 deg. above zero for nearly a week.

All of the hybrids survived the freezing without serious injury, although trees of the ordinary orange in the vicinity were in many cases killed.

It will be noticed from the above tests that both the Rusk and the Willits citranges are much hardier than ordinary oranges. While the Rusk citrange endured the freeze of December, 1901, at Experiment, Ga., it was killed, or at least died, at Auburn, Ala. On the other hand, the Willits citrange died at the Georgia experiment station and survived at the Alabama experiment station. It is well known that the condition of a tree at the time a freeze occurs has a great deal to do with its hardiness. Trees which endure the most severe winters at the latitude of Washington, D. C., have been killed in some of the freezes in Florida, owing to the fact that they were in a sappy, growing condition at the time the freeze occurred. That some of the citrange trees were killed, therefore, at certain stations does not indicate that they are tender. The fact that they have survived the same degree of cold at other stations indicates that they would have survived in all cases had they been in a properly dormant condition. It is believed from the evidence now accumulated that these two citranges may be grown without protection throughout South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, and parts of Tennessee and Texas. It is also probable that they can be grown in parts of Washington and Oregon, and in northern California, which are only slightly too cold for the orange, and in certain irrigated regions of low altitude in Arizona and possibly New Mexico. It will be remembered that the peach tree, which is considered to be fairly hardy, suffered very severely in Georgia fn the freeze of December, 1901, to which these citranges were exposed. Large peach trees were frozen to the ground, and the damage to the peach industry was very great. The range of latitude at which the citrange may be safely grown has not been fully determined, but it is believed that they will succeed in any of the above-named places where the altitude is not too high.

OF WHAT VALUE IS THE CITRANGE?

The fruits of the citranges thus far produced are small, acid, and bitter, and from the standpoint of the ordinary orange grower would be considered practically worthless. This opinion, however, would be based entirely on a comparison of the citranges with oranges of fine quality such as are produced in Florida and California. When it is considered that these fruits can be grown through the Gulf and South Atlantic States without protection, where there is now a dearth of acid fruits, their great value can be understood. Both the Rusk and the Willits citranges make a refreshing "citrangeade," similar to lemonade and limeade. It is also very similar to the orangeade made from the native sour oranges of Florida. The citrangeade has been tested by a large number of people, and all who have made a comparison pronounce it fully equal to lemonade or limeade, while some think it superior. The fruits are exceptionally juicy, the Rusk citrange in particular giving a much larger proportion of juice than the best lemons on the market. The fruits make excellent pies and marmalade, and for this purpose they are probably equal to the orange or lemon. Fortunately, the pies and marmalade made from the two fruits are of distinctly different quality, and both differ again from the lemon in this respect. The Rusk citrange has also been found to make an excellent preserve. The fruits will probably prove valuable for general culinary purposes in the making and flavoring of cakes, for use in making jellies where lemons are now employed, and probably in many other ways. While they are too acid to eat out of the hand they will be found very palatable to anyone enjoying acid fruit, especially when eaten with sugar. The citrange will probably prove of value mainly as a home fruit for cultivation throughout the Southern States mentioned above, where the sweet orange, the lemon, and the lime cannot be grown. A few trees should be cultivated in every yard in this section. The trees are attractive in shape and semi-evergreen, so that they will make desirable lawn trees. Wherever a home can be supplied with them, it will be possible on the warm days between the 1st of September and the 1st of November to pick a few fruits and make a desirable, refreshing beverage. It is believed that they will prove a decided boon to a very large section of the country. While the fruits already obtained present results far-reaching and important, even more striking and valuable results will doubtless be obtained when seed from these fruits can be grown and selections of the best citranges made from among their progeny. These two citranges, it is confidently believed, will be the progenitors of a large and numerous group of hardy, edible fruits.

THE TANGELO, A NEW GROUP OF LOOSE-SKINNED CITRUS FRUITS.

During the course of these experiments a hybrid has been produced between the pomelo and tangerine which occupies a position intermediate between these two well-known fruits. It is neither a pomelo nor a tangerine, but is different and unique and bids fair to take a place by itself. The fruit is intermediate in size between the two parental varieties, has the easily removable rind of the tangerine, and in flavor is somewhat sweeter than the pomelo, with less bitterness. It is distinct from any of the various groups of citrus fruits and should, therefore, be referred to a new group. The term "tangelo" is suggested by the writers as a name for this group of loose-skinned fruits, which lie midway between the pomelo and tangerine, the word being a combination of the first syllable of the word *tangerine*, with the ending of the word *pomelo*. A variety of citrus fruits known as the "nocatee," which has already been described and introduced, is apparently somewhat similar to this fruit and is evidently a hybrid between the tangerine and pomelo. This and the new Sampson tangelo, which is described below, are at present the only two varieties that can be referred to the tangelo group.

THE SAMPSON TANGELO.

NAME AND ORIGIN.—The Sampson tangelo is a hybrid between the ordinary pomelo (female parent) and the Dancey tangerine (male parent). The fruit from which the seedlings came was from a cross made in the grove of Mr. Frank Savage, at Eustis, Fla. The hybrid fruit contained a very large number of seeds, seventy-six in all, which gave a total of 106 seedlings, several of the seeds having produced more than one seedling. A large majority of these seedlings have not yet fruited, but of those that have borne fruit all have the appearance of pure pomelo, except No. 1,316, which exhibits characters plainly intermediate between the pomelo and the tangerine, being about midway between the two in size and other characteristics. The color of the fruit is darker orange than the pomelo, though not so red as the tangerine, and the color of the pulp is more nearly like the tangerine than any of the varieties of the pomelo. In flavor it is sprightly acid, but rather sweeter than the pomelo, and it has a slightly bitter taste derived from that parent. Its most pronounced characters, however, are the looseness of the rind and the ease with which the segments can be separated; in these qualities it partakes of the nature of the tangerine. The fruit may be described as a small "kid-glove" pomelo.

DESCRIPTION OF FRUIT AND TREE.—Fruit compressed-spherical, slightly drawn out at stem end like tangerine; of medium size, averaging 2½ inches in diameter and about 2¾ inches in height; weight from 163 to 248 grammes; calyx persistent as in common orange; color, chrome yellow, considerably darker than the pomelo, though not so red as the tangerine; specific gravity about the same as water; skin thin, about one-eighth of an inch in thickness, loose and easily removable, like the skin of the tangerine; surface smooth and glossy; oil glands large and conspicuous, rendering the rind translucent; larger glands oblate spherical, smaller ones nearly spherical; segments, nine to eleven, separating easily like tangerine; membranes thin and tender; axes small and compact, about one-half inch in diameter; rag very slight; quality excellent; texture very tender and juicy; flavor sprightly subacid, somewhat sweeter than pomelo, but with more acid than the tangerine, and with a slight bitter taste derived from the pomelo; color of pulp, ochraceous-buff to orange buff, differing in this respect from both parents; seeds, ten to fifteen, medium in size; aroma slight, giving suggestion of both parents; in general appearance very attractive, resembling small pomelo, but of rather darker orange color; tree evergreen, tender, vigorous, and productive, having general character of ordinary tangerine; leaves unifoliolate, with comparatively narrow petioles like tangerine.

USES OF THE TANGELO.

The Nocatee tangelo is not familiar to the writers, and they are unable to pronounce on its value. The Sampson tangelo, however, is very likely to become an important commercial fruit. Those who have tasted it pronounce its flavor excellent. Its very attractive appearance and color of flesh, together with the ease with which it can be peeled and the segments separated, favor its growth in popularity. The bitter taste which is so pronounced in the pomelo is in the Sampson tangelo reduced to a suggestion which only adds to its sprightliness. Altogether it is a sprightly acid, highly flavored fruit, being not so acid as the pomelo and not so sweet as the tangerine, and it is believed that many people will prefer it to either of these fruits. It is a vigorous grower and probably productive. It is of course no hardier than either parent and can be grown only in the orange belts of Florida and California. It is believed that the Sampson tangelo will become a popular breakfast fruit, to be used by peeling and separating the segments, as in the case of the tangerine, and eaten by dipping the segments in sugar. The popularity of the pomelo, or grape fruit, is due largely to its use as a breakfast appetizer, and it is recognized as especially beneficial for invalids. It is also thought that the bitter element, probably due to some alkaloid, furnishes a slight healthful stimulation. The pomelo, however, is too bitter and acid to suit the taste of many. The Sampson tangelo, being somewhat sweeter and lacking much of the bitter taste, would seem to furnish a happy medium between the tangerine and pomelo, which would recommend it to many who find the pomelo too harsh. In some ways the flavor of the tangelo resembles the most improved bitter-sweet orange, but is certainly superior to it. Altogether, it is believed that the fruit will occupy a place not now filled by any other citrus fruit and that it will become valuable for commercial cultivation. Its superior quality and the "kid-glove" character of the rind mark it as a distinct and most valuable creation.

NEW TANGERINE ORANGES.

One of the primary objects in the citrus breeding experiments was to produce hybrids between the common sweet orange and tangerine in order to secure a new fruit having the size, quality, and flavor of the ordinary orange combined with the loose, easily removable rind of the tangerine. A few of these hybrids have now fruited, and two of them, crosses of the Dancey tangerine with pollen of the Parson Brown orange, have produced fruits which are of considerable value. Both of these seedlings were grown from one fruit which was the result of a cross made in the grove of Mr. W. K. Trimble, of Braidentown, Fla. While the fruits were supposed to be hybrids, they nevertheless resemble the tangerine orange in all important characters, differing from the Dancey tangerine, which was used as the mother parent, mainly in being larger and considerably earlier in time of maturity and in being of rather better quality.

THE WESHART TANGERINE.

NAME.—One of these new tangerines, the Weshart, is named in honor of Mr. W. S. Hart, of Hawks Park, Fla., in recognition of his valuable assistance in these experiments. Both of the new tangerine oranges were grown and fruited under his supervision.

DESCRIPTION OF FRUIT AND TREE.—Fruit compressed-spherical, slightly protruded at stem end and somewhat depressed at the apex, having the same general form as the tangerine. Size from 2½ to 3 5-16 inches in diameter, averaging about 3 inches. Height from 2¼ to 2⅞ inches. Color, deep orange red, like tangerine. Surface smooth, glossy, and very attractive, much smoother than the Trimble tangerine, to be described later. Rind loose, as in other varieties of this group; thin, from 3-32 to ⅛ inch thick. Oil glands medium size, surface of rind slightly sunken over the largest. Segments mainly ten, easily separable. Membranes tender. Axis hollow, from ⅜ to 1 inch in diameter, star-shaped. Rag tender and in moderate quantity. Quality and texture excellent. Flavor sweet, subacid, very juicy. Bouquet characteristic and very pleasant. Color of pulp, buff orange; cells small like ordinary tangerine. Seeds few, from nine to fifteen. Tree vigorous and prolific. Foliage branching, and shape of tree like the tangerine. Season very early for tangerine.

The Weshart tangerine is a delicious fruit of exceptionally fine appearance and flavor. Its large size, superior quality, and earliness indicate that it will prove of great value for general cultivation in orange regions. In general it is smoother in surface and rather smaller than the Trimble tangerine, but is apparently superior in flavor.

THE TRIMBLE TANGERINE.

NAME.—The Trimble tangerine is named after Mr. W. K. Trimble, of Braidentown, Fla., in whose grove the original hybrid was produced. The resulting seedling was grown and tested in the grove of Mr. W. S. Hart, of Hawks Park, Fla., as was also the Weshart tangerine.

DESCRIPTION OF FRUIT AND TREE.—Fruit compressed-spherical, of same shape as the Weshart tangerine, and with slightly protruded stem end and depression at apex. Size large, from 3 to 3⅝ inches in diameter and from 2 to 2⅜ inches in height. Heavy, averaging about 5.6 ounces. Color deep orange red, like Dancey tangerine, or slightly darker. Surface somewhat rough and bumpy, in larger specimens similar to King orange; frequently with slight grooves running from base to apex. Oil glands small, with the surface of the rind slightly sunken over the larger ones. Rind loose, thin, 3-32 to ⅛ inch in thickness. Segments 9 to 11. Membranes thin and tender. Axis ¾ inch in diameter and hollow. Rag comparatively little for fruit of this class. Flesh deep orange yellow and very attractive, tender, and juicy. Pulp cells medium size. Flavor sprightly acid and excellent, with pronounced bouquet. Seeds few, averaging about 10. Tree vigorous and prolific. Foliage branching, and shape of tree like Dancey tangerine. Season of maturity very early for tangerine.

The Trimble tangerine is a fine large tangerine, the rough, bumpy appearance serving to distinguish it from other tangerines, and at the same time not detracting from its appearance. In general the fruits are somewhat larger than those of the Weshart tangerine, but are very inferior to them in flavor.

GENERAL QUALITIES OF NEW TANGERINES.

The Weshart and Trimble tangerines, it will be seen from the above descriptions, differ from other varieties of tangerines primarily in being larger and earlier and more highly flavored. Fruits of these two varieties have been received in some quantity for the past two seasons, and have been compared with those of the Dancey tangerine, grown by Mr. W. S. Hart in the same grove, and with the best tangerines that could be procured on the market. In every case they have been superior in color, size, and flavor. In Mr. Hart's grove they have uniformly colored up and ripened about two weeks earlier than the Dancey tangerine, and it would thus seem that they may be highly recommended for general culture. They have not been tested in any other parts of Florida nor in California, and it can not be definitely stated what they will do under different conditions. The Dancey tangerine, however, is generally cultivated, and it is believed that the new fruits will prove superior to this variety in almost every respect. While these two tangerines developed from a fruit of Dancey tangerine crossed with pollen of Parson Brown, they show no clear indication of intermediate characters. They are in every respect, so far as can be judged, true tangerines. The Parson Brown orange, which was used as the male parent, is a typical orange and one of the earliest varieties cultivated. The new fruits are larger than those of the tangerine, and it may be that the large size, and their earliness, are qualities derived from the Parson Brown. If it were not for the possibility of their having developed from adventive embryos, this would be the

normal conclusion. It is, however, impossible to determine this matter from the characters exhibited by the trees up to the present time. As the trees mature other characters may become visible which may throw some light upon this point. Practically speaking, however, it does not matter whether the new fruits have any orange blood in them, so long as they possess valuable qualities. The Weshart and Trimble, it should be remembered, are tangerine varieties, and, like the ordinary tangerine or common orange, can be cultivated only in Florida and California, where citrus fruits are ordinarily grown.

THE NORTH AMERICAN EAGLES AND THEIR ECONOMIC RELATIONS.*

WHEREVER eagles occur commonly they are among the best known of birds. They appear frequently in the language and legends of ancient peoples, and often have been chosen as national emblems, since for size, powerful flight, and fierce nature they have been celebrated from earliest historic times. Though found in almost every quarter of the globe—North America, South America, Europe, Asia, Africa, Australia, and the East India Islands—they are most numerous in Europe, Asia, and Africa. North America possesses but four species, only two of which—the golden eagle and the bald eagle—are of general distribution and thus of particular economic interest in this region; while the harpy eagle reaches our territory, if at all, as merely a casual visitor to Texas, and may properly be left out of the present consideration.

Eagles are popularly supposed to be quite different from hawks, but, in a word, they are nothing more than large hawks. Few birds exceed or even equal them in duration of life, for they reach sometimes the age of nearly a hundred years. They are not usually sociable, but live singly or in pairs and dwell in the wilder places in all kinds of country from tropical deserts to the Arctic regions. In their search for food, however, they often wander far, and emboldened by hunger even approach the abodes of man. In story books and newspapers eagles have many times been accused of carrying off young children, but most if not all such tales are wholly unreliable.

Eagles are flesh eaters, and since they consume large quantities of whatever animal food is most accessible they become at times an economic factor of some importance, though whether beneficial or injurious in a given region is not always easy to say. In places overrun by the smaller noxious mammals they frequently perform valuable service by thinning the ranks of such pests, and the fondness of some species for carrion is an added source of benefit to man. But if, perchance, they do render us some good deeds, they offset these by wholesale destruction of water fowl and game birds and by raids upon the sheepfold, the goat pasture, the cattle pen, and the poultry yard. Thus a just verdict must pronounce them not far from neutral in economic influence. Where and when they are doing good they ought to be carefully protected; if at any time or place they become harmful, means should be taken to obviate the damage they cause; but it would be unnecessary and unwise to declare against all eagles a general war of extermination, since neutral species always bear an important part in the balance of nature, an equilibrium that man should hesitate to disturb.

Preservation of Fresh Yolk of Egg.—A new method of preserving fresh yolk of egg has appeared, for which Dr. Friedrich Keller, Bingen on Rhine, has taken out a patent.

According to the inventor of this method, methyl alcohol has the defect that yolk of egg with which it is mixed in quantities of from 8 to 10 per cent and more curdles after a time and in the course of a few weeks is entirely transformed into a gelatinous mass, becoming useless for many purposes. He has now discovered that this curdling can be almost entirely prevented by adding to the yolk small quantities of substances such as neutral salts, alkalies, alkaline carbonates, and acids, which have the property of dissolving the ovovitelline contained in it. It is immaterial whether these substances are added to the yolk itself or to the methyl alcohol or to the compound of the two. He claims that yolk of egg preserved by this process keeps well, remains fluid, i. e., maintains approximately the consistence of fresh yolk of egg, and may be used for many purposes owing to the great volatility of methyl alcohol, the boiling point of the latter being 60 deg. C. The quantities of salts, acids, or alkalies added are so small that they need not be considered in using the yolk.

Keller gives the following formula as a specimen: To 1,000 parts by weight of fluid yolk of egg add 80 to 100 parts by weight of methyl alcohol, in which 1 to 2 parts by weight of tartaric acid or citric acid have been dissolved, and mix thoroughly.

Whether and to what extent the addition of foreign substances to an article of food is legally permissible is a question which has still to be decided.

To Protect Jute Against Fire.—According to Klut (Pharmaz. Ztg., Berlin) a 10 per cent aqueous solution of ammonium phosphate is the best protective against fire. In general, this salt is well known as one of the best and safest means of rendering articles fireproof. Moreover, it possesses the advantage that of all the protectives against fire, it is the least injurious to the tissues.

* Reprinted from Bulletin No. 27, published by the Biological Survey of the Department of Agriculture.

SCIENCE NOTES.

It seems incredible, but is nevertheless true, that at the present time there are still in the United States many physicians who oppose the idea that the mosquito is the sole means by which yellow fever is carried from one person to another. They refuse to believe that the natural disease can not be contracted in any other way than through the bite of the mosquito. The fact, however, has been repeatedly demonstrated and the evidence in its support has now become overwhelming. We can not expect that the active practising physician shall keep abreast of all modern advances in scientific medicine, and the numerous contradictory statements that have been made in regard to yellow fever have afforded full justification for skepticism on the part of such as aim to be conservative. While strong conservatism is to be commended, persistent skepticism is to be condemned. It is perfectly justifiable to refuse to receive statements that revolutionize our accepted ideas, so long as they are based upon the assertions of a single observer or a single set of observers, but when these observations have been confirmed by competent unbiased persons in different parts of the world, such statements must then be accepted as facts, just as we accept other statements in regard to history, geography, and the sciences in general.

Though it is apparently impossible to isolate from a water any particular nitrogenous organic compound known to occur in sewage, the amount of nitrogen and the amount of carbon contained in these compounds can be determined, and among the first, if not the first, to attempt to determine from the amount of nitrogen and carbon in a water whether the organic matter was of animal or vegetable origin was the late Sir Edward Frankland. On examining the residue left on evaporation of water from peat bogs he found the ratio of nitrogen to the carbon was as 1 to 12, while in the residue from fresh sewage it was as 1 to 2.1, and in the residue from polluted water, as water containing leakage from cesspools, as 1 to 3.1. From these and similar observations he concluded that in surface waters the ratio of the organic nitrogen to the organic carbon in the residue left on evaporation of such waters afforded trustworthy evidence as to the source of the organic matter. Thus he concluded, that if the ratio was as low as 1 to 3 the organic matter was of animal origin; if as high as 1 to 8 it was chiefly, if not exclusively, of vegetable origin, and that if the ratio was between these two proportions the analyst must be guided in his opinion by the amount of inorganic nitrogen the water contained, and by his knowledge of the surroundings of the source of the water. This work of Frankland deserves much closer study than it has as yet received. His idea that reliable information regarding the source of the organic matter in a water can be obtained from a knowledge of the amount of organic carbon and organic nitrogen is, in my opinion, undoubtedly sound. The reason why this method has not been more generally adopted is undoubtedly due to the difficulties in correctly determining these two factors by the process used by Frankland, which consisted in measuring the amount of carbon dioxide formed and the amount of nitrogen given off, by the combustion of the residue left on evaporation. If as simple a process for determining the organic carbon as we now have for determining the organic nitrogen could be devised, Frankland's method for deciding upon the character of a surface water would receive the careful study it certainly deserves.

In an article published in a recent issue of the Revue Scientifique, M. Bertin, the well-known naval architect, maintains that the heights and lengths of ocean waves are often greatly over-estimated. The most reliable method of determining the length is, he states, to reduce it from the period, since there is a simple relation between this length and the time of complete oscillation. The longest wave of which he has cognizance is 800 meters (2,590 feet) from crest to crest, its period being 23 seconds. These long waves, he states, are never very high. In deep water the height of a wave 800 meters long will not, at most, be more than 16 meters, or one-fiftieth its length. Much greater heights than this have, he says, been recorded, particularly from small craft, but the observations were quite unreliable. The error arises mainly from the fact that the observer has failed to take into account the fact that the vessel he is in floats with its deck parallel to the surface of the wave, and not to a true horizontal plane. With the reference plane thus tilted, grossly exaggerated estimates of the true height of the waves become possible. Where care has been taken to avoid this source of error, the highest wave recorded in open water has measured 13 meters from hollow to crest; but M. Bertin believes that heights of 16 meters may, perhaps, be met with in the Southern seas. On entering shoal water waves become higher and shorter, so that a wave which has a height of 13 meters in open water may attain 16 meters on striking a shoal, while if it meets a more or less vertical obstacle, it may shoot up to double this height; and at the Eddystone light, he states, solid green seas have been known to reach a height of 32 meters. Waves of 800 meters length are, he continues, very rare, since a period of ten seconds is not often exceeded, which corresponds to a length of 160 meters (about 520 feet). More commonly the period is six to eight seconds, and the length 160 feet to 320 feet. Heights of over 10 meters (33 feet) are rare, but short waves are relatively higher than long ones, a wave 100 feet long being commonly 8 feet to 16 feet high. M. Bertin further points out that there appears to be a minimum to the size of ocean waves, as well as a maximum, since there is a connection between the size and the velocity of the wind producing them. Thus waves measuring ¾ inch from crest to crest would correspond to a wind moving at about 2 feet a second; and he questions whether a wind moving more slowly than this would have power to raise waves at all.

ENGINEERING NOTES.

The Icelandic government has finally decided to build a railroad in Iceland. It will run from Reykjavik about forty-five miles through a fertile part of the country, where a similar railroad was planned many years ago by an American.

The American Car and Foundry Company has obtained a contract from the administration of the Italian state railways for one thousand cars. This is the first contract of its kind allotted to an American concern. Five hundred box cars and a similar number of coal cars have been ordered. They will be built at Trafford Park, near Manchester, at the firm's English plant.

It is probably safe to say that closed feed-water heaters bought in competition are seldom provided with sufficient surface to raise the temperature of the boiler feed water to more than 200 deg. Closed heaters of the steam-tube type must have shells strong enough to withstand a pressure in excess of that in the boiler. A relief valve should be placed in the pump discharge line, otherwise excessive pressure will be produced in the heater when the boiler-feed valves are suddenly closed, and will cause undue wear and tear.

There was a constant increase in the production of Bessemer steel until 1887, when that of ingots reached 2,936,035 tons, and rails 2,101,904; the latter sold at an average price of $37.08 per ton, with currency at par; 1887 was a year of unparalleled railway building in the United States, followed by a period of reaction, with the result that while the output of ingots kept up, that of rails fell off, and it was not until 1899 that the rail production again passed the two million-ton point. In that year there were turned out 7,586,354 tons of Bessemer, and 2,947,316 tons of open-hearth ingots, and 2,270,585 tons of rails, all of Bessemer steel, the latter selling for an average price of $28.12 per ton. Following that year there was a continued increase in the output of open-hearth steel, while that of Bessemer remained more nearly constant, until in 1905 there was made 10,919,272 gross tons of Bessemer, 8,444,836 gross tons of open-hearth ingots, and 3,375,611 gross tons of rails, 183,264 tons of which were of basic open-hearth steel. The rails were practically all sold at a uniform price of $28 per ton, which has been the standard price since and including 1902.

One of the problems which is much in evidence at the present time is that of speed variation when the motive power is supplied by an internal-combustion engine. Much ingenuity has been displayed by the designers of motor cars in obtaining a variable drive of that kind, and in some cases the mechanical connection between the motor and road wheels has been replaced by an electrical connection in the shape of a dynamo and motor, so that all change-speed gearing is avoided. This has been done more particularly in certain gasoline-electric omnibuses. The same difficulty occurs in boats driven by gasoline motors. When the boats are small there is not much objection to some form of gearing for reversing, but when they are of any considerable size the difficulty becomes greater. The "gasoline-electric" principle is therefore finding its way into the problem of ship propulsion, the latest developments being by Mr. Del Proposto. The internal-combustion motor used is the Diesel, and by employing engines of 1,000 horse-power in tandem, and three propellers, it is proposed to get a power up to 6,000 horse-power. By using a "direct drive" with a magnetic clutch, the use of the generators and motors is avoided at high speeds, but the control is always electrical. This last feature has the great advantage of giving control direct from the bridge instead of using the engine room as a kind of large relay.

Producer gas is objected to by some manufacturers because of the relatively high proportion of carbon monoxide. This gas, which has a specific gravity rather less than one, is more dangerous than carbonic acid gas, and is particularly poisonous. Obviously, therefore, the manufacturers of producer-gas apparatus take every possible precaution to see that there is continuous and ample ventilation wherever gas generators are placed. Generators in which gas is produced under pressure are more dangerous than those in which gas is produced under suction, for in the former when there has been a leaky joint producer gas escapes and the air becomes vitiated, while with suction gas a leaky joint means that more air is drawn in. With ordinary precautions, such as all makers invariably suggest, and indeed emphasize, there is no danger whatever, but these points should be remembered. With electrical apparatus, especially with running machinery, it is very essential to know where danger from a shock is likely to be, and one cannot blame either the apparatus or the manufacturer if through sheer carelessness a short circuit or a bad shock takes place. Similarly with producer-gas plants. With all engineering apparatus it is assumed that those who have the working of them at least possess common sense, and with this and ordinary care there is no danger whatever.

TRADE NOTES AND FORMULÆ.

"Unica" Paint Remover.—This is a Dutch preparation, the object of which is to remove old paint and varnish from wood and metal. It consists of a mixture of about equal parts of carbonic disulphide and purified acetone, to which about 5.4 per cent of purified mineral wax is added.

Fig-Bread.—Fig-bread is a food of Spanish origin, consisting of dried, minced, and apparently pounded figs, and, in a lesser degree, of entire unroasted hazelnut and stone-pine kernels and roasted earth-nut kernels. It is pressed into tablets and covered with flour wafers.

To Make Briquettes from Coal Not Well Adapted for This Purpose.—The Desulfurit Company, Limited, of Breslau, makes briquettes from unsuitable coal, coke, etc., by the following process, described in their German patent: Slaked or unslaked lime is ground and well mixed when dry with the fuel from which the briquettes are to be made. The mass is then subjected to a thorough and long-continued mixing and kneading with water, after which it is molded into pieces of any desired shape or size by means of the rope-press. In this way very durable briquettes can be made, using only small quantities of lime. When the briquettes burn, any sulphur that may be present immediately combines with the lime instead of escaping in the form of sulphurous acid.

Protective Covering for Steam Pipes.—The best covering for steam pipes is formed by alternate layers of felted hair and asbestos. Cork has not proved so reliable, as the pores admit the air. Mineral wool, infusorial earth, and magnesium carbonate can also be recommended. As stated in the Zeitschrift für Elektrotechnik, experiments made to test various coverings show the following results, expressed in comparative values:

Alternate layers of felted hair and asbestos	100
Granulated cork	77
Mineral wool	75
Infusorial earth	71
Magnesium carbonate	70
Infusorial earth with hair	53
Asbestos board	47
Infusorial earth with asbestos	46
Crude asbestos	36
Ordinary air-space	18

Directions for Dry Mounting of Photographs.—A solution of shellac in alcohol is prepared by pouring the spirit over the shellac and slightly heating the solution in a water-bath. The solution, which must not be too thick, is spread uniformly with a brush over the back of the photograph. When dry, the photograph is laid on the cardboard, covered with a thin linen cloth and a hot flatiron passed over it; it will immediately adhere firmly and neatly to the cardboard. The many disadvantages of wet mounting are avoided by this process.

Another method is similar to that described above, differing only in the composition of the dry adhesive. A piece of tissue-paper is coated by means of a broad brush with the following solution:

White gum lac	30 parts by weight.
Gum elemi	3 parts by weight.
Canada balsam	5 parts by weight.
Alcohol (94 deg.)	100 parts by weight.

After drying for about 15 minutes, the other side is coated and likewise dried. The piece of paper thus treated is placed between the photograph and the cardboard and a hot flat-iron passed over it. The sheets will adhere perfectly without warping or stretching and the photograph will be protected against any damage from sour paste. By again applying heat the photographs may easily be separated from each other.

Collodion Varnish for Incandescent-Light Mantles.—A solution of 13 parts by weight of soluble pyroxyline in 500 parts of anhydrous (absolute) alcohol and 500 parts of sulphuric ether with the addition of 75 parts of technically pure castor oil and 20 parts of camphor, or a solution of 14 parts of celluloid in 500 parts of sulphuric ether and 500 parts of alcohol with 75 parts of castor oil has been found to constitute the most effective varnish. The solution is clarified by allowing it to stand for a week or more in the sun, and it must be filtered through tulle or muslin before use to remove any solid impurities.

To saturate the mantles, the latter are suspended by means of small white-metal hooks on the upper edge and then pushed upon a glass rod so that a number of them can be dipped at the same time into a sufficiently large vessel containing the collodium solution. They are allowed to remain in the solution for a few minutes, then removed and placed in a suitable frame together with the same glass rod.

The drying process takes place very rapidly owing to the great volatility of the solution, and care must be taken when the mantles are dipped into or removed from the liquid, and also when they are drying, that they do not come into contact with and adhere to each other. The meshes of the mantles are firmly connected together by the collodium solution and will bear transporting, touching with the hands and even slight knocks. The addition of castor oil prevents a too rapid and explosive burning off of the mantles, while an excess of the same would retard the drying; too much camphor renders them brittle and pliable. An excess of ether in the solution also has the effect of rendering the mantles more brittle.

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